Hydraulic Fracturing and the Baseline Testing of Groundwater

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INTRODUCTION

Hydraulic fracturing is a process that often is used to stimulate the production of oil and natural gas from low permeability formations. The process is controversial. Some people passionately support the use of hydraulic fracturing, while others fervently oppose it. Much of the controversy arises from the fact that many people fear that hydraulic fracturing might cause contamination of underground sources of drinking water. In part, the public debate and disagreement regarding hydraulic fracturing is fueled by competing opinions regarding how society should balance the tradeoffs between economic development and environmental protection. But this is only part of the disagreement.

Proponents of hydraulic fracturing often say that the process carries little risk and there are no documented cases of hydraulic fracturing contaminating drinking water.[1] Its opponents contend that the process carries a high risk and that it already has contaminated several sources of drinking water.[2] Thus, the opposing sides of the fracturing debate also disagree about facts—namely, whether hydraulic fracturing is actually a threat to groundwater.

One of the reasons this disagreement about facts persists is that determining the cause of groundwater contamination is challenging. Several factors contribute to this difficulty. First, con-

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1. *See, e.g.*, Rock Zierman, *Why so Much Fracking Hysteria?*, L.A. TIMES, June 21, 2013, at A19.

2. *See, e.g.*, *The Rapid Expansion of Natural Gas Drilling Across the Nation Endangers Human Health and the Environment*, NAT. RES. DEF. COUNCIL, http://www.nrdc.org/energy/gasdrilling/ (last visited Feb. 18, 2014).

tamination is caused by a wide variety of natural causes and human activities. Second, when contamination exists, its presence is not always obvious. Thus, when contamination is discovered, it may have been present for a considerable time. Third, the quality of groundwater in an area often is not tested prior to oil and gas activity being conducted. Thus, if groundwater contamination is discovered after oil and gas activity has occurred, investigators may be unable to determine whether the contamination existed prior to the oil and gas activity. Some states are addressing this factor by encouraging or requiring oil and gas companies to perform "baseline testing" of groundwater quality prior to oil and gas activity.

This article discusses some of the legal and practical issues relating to baseline testing of groundwater and the rules designed to encourage or require such testing. Part I of the article discusses basic background material—why this issue is important, what fracturing is and why it is used, the basic types of fracturing, why it can be challenging to determine the cause of alleged contamination, and why baseline testing might help. Part II examines different approaches to increasing the use of baseline testing, including regulations that require such testing and legislation that creates presumptions that provide incentives to conduct such testing. Part III reviews some of the issues that will need to be decided by the individual states adopting baseline testing requirements. After a brief conclusion, an appendix describes the baseline testing rules of the states that have adopted such rules.

I. BACKGROUND

A. *Why This Is Important: Clean Water and Hydraulic Fracturing Must Coexist Because Each Is Essential*

The availability of clean water is essential. Water is needed for human consumption and agriculture. Further, modern society is dependent on electricity, and most of the power plants that generate electricity need large quantities of water. In addition, other important industrial processes also use significant amounts of water.

Oil and natural gas are also essential to modern society. At present, oil and natural gas supply more than 60% of this country's total energy, and the United States Energy Information

Administration predicts that oil and gas will continue to supply about 60% of the country's energy for decades to come.[3] Oil and gas supply a similar portion of energy in the rest of the world.[4] Oil and natural gas also serve as the feedstocks for the production of countless chemicals, polymers, and plastics that are used in common objects that many people in the world use almost every waking hour of their lives. Oil and gas are undeniably essential in modern society.

Moreover, hydraulic fracturing is critical to the production of oil and gas. By some estimates, hydraulic fracturing is used in about 90% of oil and gas wells drilled in the United States, the country that is the world's largest producer of natural gas and which is close to being the world's largest producer of oil.[5] Further, hydraulic fracturing is used in other countries as well, though perhaps not as often as in the United States.[6] Given that oil and gas are essential to modern society and that hydraulic fracturing is so critical to the production of oil and gas, a fair and reasonable conclusion is that hydraulic fracturing itself is essential to modern society.

Because clean water and hydraulic fracturing are each essential to modern society, they must coexist. Accordingly, society

3. *See What You Need to Know About Energy: Supply and Demand*, NAT'L ACADS., http://www.nap.edu/reports/energy/supply.html (last visited Feb. 18, 2014); U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2014 EARLY RELEASE OVERVIEW 11 (2014).

4. *See* BRITISH PETROLEUM, BP STATISTICAL REVIEW OF WORLD ENERGY 42 (2013), *available at* http://www.bp.com/content/dam/bp/pdf/statistical-review/statistical_review_of_world_energy_2013.pdf.

5. Hannah Breul & Linda Doman, U.S. Energy Info. Admin., *U.S. Expected to Be Largest Producer of Petroleum and Natural Gas Hydrocarbons in 2013*, U.S. ENERGY INFO. ADMIN.: TODAY IN ENERGY (Oct. 4, 2013), http://www.eia.gov/todayinenergy/detail.cfm?id=13251; *Natural Gas Production: 2012 Statistics About Natural Gas Production*, ENERDATA, http://yearbook.enerdata.net/#world-natural-gas-production.html (last visited Feb. 18, 2014); *Natural Gas Production: Crude Oil Production by Region in 2012*, ENERDATA, http://yearbook.enerdata.net/#crude-oil-production.html (last visited Feb. 18, 2014); *see also* Oil and Gas; Well Stimulation, Including Hydraulic Fracturing, on Federal and Indian Lands, 77 Fed. Reg. 27,691, 27,693 (May 11, 2012) (to be codified at 43 C.F.R. pt. 3160) (estimating that approximately 90% of oil and gas wells drilled on federal and Indian lands are hydraulically fractured).

6. *See, e.g.*, Zhao Jinzhou et al., *China Developing Strategy for Horizontal Fracturing Technology*, OIL & GAS J., July 1, 2013, at 70; G. Gutierrez et al., *Improvements in Multistage Fracturing, Remolino Field, Mexico* (SPE Hydraulic Fracturing Tech. Conference, SPE No. 168576, 2014); Mohammed Aly Sergie, *Hydraulic Fracturing (Fracking)*, COUNCIL ON FOREIGN RELATIONS (Oct. 15, 2013), http://www.cfr.org/energy-and-environment/hydraulic-fracturing-fracking/p31559.

must adequately protect groundwater without unduly restricting the use of hydraulic fracturing. But uncertainty or disagreement regarding hydraulic fracturing's risk makes determining what protection is adequate more difficult. Baseline testing can reduce this uncertainty and disagreement.

B. *What Is Fracturing and Why Is It Used in Oil and Gas Wells?*

Most deposits of oil and gas are not located in underground caverns or in large underground void spaces.[7] Instead, the oil and gas are located in the small pore spaces of certain subterranean rock formations.[8] In oil and gas operations that do not involve hydraulic fracturing, an oil or gas well is drilled to such a formation, and the oil or gas must then travel through the "solid" rock to reach the well.[9] In some formations, the oil or gas can easily do that by moving from one pore space to the next, through interconnections between the pores, or sometimes by flowing through natural fractures in the rock.[10]

But in some formations that contain oil or gas, there is relatively little natural fracturing, and the interconnections between pore spaces are narrow and too few in number for oil or gas to flow through the rock at a significant rate.[11] Such formations are sometimes described as being "tight"[12] or as having low permeability (a solid object's "permeability" is a measure of the ease with which a fluid moves through the solid).[13] If the formation's per-

7. RICHARD C. SELLEY, ELEMENTS OF PETROLEUM GEOLOGY 239 (2d ed. 1998); JAMES G. SPEIGHT, THE CHEMISTRY AND TECHNOLOGY OF PETROLEUM 103 (3d ed. 1999). Indeed, the word "petroleum" is Latin for "rock oil." *See* MERRIAM-WEBSTER'S COLLEGIATE DICTIONARY 809, 869 (10th ed. 1993) (defining "oleum," "petr," and "petroleum"); DONALD J. BORROR, DICTIONARY OF WORD ROOTS AND COMBINING FORMS 66, 73 (1960) (describing both Latin and Greek origins).

8. SELLEY, *supra* note 7, at 239; SPEIGHT, *supra* note 7, at 103.

9. SPEIGHT, *supra* note 7, at 164–65; MARTIN S. RAYMOND & WILLIAM L. LEFFLER, OIL AND GAS PRODUCTION IN NONTECHNICAL LANGUAGE 167 (2006).

10. RAYMOND & LEFFLER, *supra* note 9, at 39.

11. *See* NORMAN J. HYNE, NONTECHNICAL GUIDE TO PETROLEUM GEOLOGY, EXPLORATION, DRILLING, AND PRODUCTION 158 (2d ed. 2001) (explaining that the interconnections between pores sometimes are called "pore throats").

12. *See* HOWARD R. WILLIAMS & CHARLES J. MEYERS, MANUAL OF OIL AND GAS TERMS 1110 (10th ed. 1997) (defining "tight sands"); *see also* GROUND WATER PROT. COUNCIL, U.S. DEP'T OF ENERGY, MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES: A PRIMER 15 (2009), *available at* http://www.gwpc.org/sites/default/files/Shale%20Gas%20Primer%202009.pdf [hereinafter SHALE GAS PRIMER] (referring to "tight gas").

13. *See* WILLIAMS & MEYERS, *supra* note 12, at 775 (defining "[p]ermeability of rock" as "[a] measure of the resistance offered by rock to the movement of fluids through it"); *see*

meability is too low, oil and gas will not move through the formation quickly enough to justify the expense of drilling a well.[14] Essentially, the oil and gas remain trapped in isolated pore spaces.

If a person could create new cracks or fractures in the rock formation, any oil and gas in the formation could use those fractures as supplemental pathways to the wellbore.[15] This would result in higher rates of oil and gas production, and the higher rates of production could make drilling economical, despite the formation's low permeability.[16] The process of creating such fractures is called "fracturing."

C. *What Are the Basic Types of Fracturing?*

Over time, the oil and gas industry have used two major types of fracturing: (1) explosive fracturing and (2) hydraulic fracturing.

1. Explosive Fracturing

Fracturing processes have been around for almost as long as the modern oil and gas industry. "Colonel" Edwin Drake drilled the first oil well in the United States near Titusville, Pennsylvania in 1859.[17] By the 1860s, some well owners had begun using a practice called "explosive fracturing."[18] In that process, the well's operator would fill a metal container called a "torpedo" with nitroglycerin, lower the torpedo into the well, and detonate it.[19] The

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also SHALE GAS PRIMER, *supra* note 12, at 82.

14. *See* DANIEL YERGIN, THE QUEST: ENERGY, SECURITY, AND THE REMAKING OF THE MODERN WORLD 328 (2011) [hereinafter YERGIN, THE QUEST].

15. SHALE GAS PRIMER, *supra* note 12, at 56; David E. Pierce, *Carol Rose Comes to the Oil Patch: Modern Property Analysis Applied to Modern Reservoir Problems*, 19 PENN. ST. ENVTL. L. REV. 241, 259–60 (2011).

16. *See* SHALE GAS PRIMER, *supra* note 12, at ES-4; YERGIN, THE QUEST, *supra* note 14, at 328–29.

17. DANIEL YERGIN, THE PRIZE: THE EPIC QUEST FOR OIL, MONEY & POWER 10–11 (1990) [hereinafter YERGIN, THE PRIZE].

18. *See* HYNE, *supra* note 11, at 422; *see also* Roberts v. Dickey, 20 F. Cas. 880, 884–85 (W.D. Pa. 1871) (No. 11,899) (discussing a patent granted in 1866 for an invention relating to explosive fracturing); People's Gas Co. v. Tyner, 31 N.E. 59, 59–60 (Ind. 1892) (providing an example of a nuisance action in which plaintiffs complained about use of explosive fracturing in urban area).

19. HYNE, *supra* note 11, at 422–23; *see also* GREGORY ZUCKERMAN, THE FRACKERS 27–28 (2013) (noting that the earliest explosive used in explosive fracturing was gunpowder, which soon was replaced by nitroglycerin).

resulting explosion would fracture the surrounding rock and dramatically increase the well's rate of oil production.[20] Handling nitroglycerin was dangerous,[21] but the process was effective and continued to be commonly used for several decades into the 1900s.[22] Explosive fracturing, which sometimes was called "shooting a well,"[23] is seldom used today because the use of hydraulic fracturing has largely superseded it.[24]

But even as the use of explosive fracturing with nitroglycerine began to decline, several notable experiments were performed using a different explosive. For example, in the late 1960s and early 1970s, the U.S. Atomic Energy Commission ("AEC") experimented with using underground nuclear explosions to fracture low permeability formations.[25] The AEC conducted the experiments at two locations in Colorado and one in New Mexico.[26] The experiments were part of the AEC's "Plowshare" program, in which the AEC sought to develop peaceful uses for nuclear energy.[27] The Soviet Union also experimented with using nuclear explosions to stimulate oil and gas production.[28] Both the United States and Soviet experiments succeeded in substantially boosting the rate of natural gas production from the formations where the tests were conducted, but the gas that was produced contained radiation.[29]

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20. HYNE, *supra* note 11, at 422–23.

21. *People's Gas Co.*, 31 N.E. at 59 (discussing danger of nitroglycerin); Joe Schremmer, *Avoidable "Fraccident": An Argument Against Strict Liability for Hydraulic Fracturing*, 60 U. KAN. L. REV. 1215, 1249 (2012). For a discussion of how the stimulation process works, see *How Does Well Fracturing Work to Stimulate Production?*, RIGZONE, http://www.rigzone.com/training/insight.asp?insight_id=319&c_id=4 (last visited Feb. 18, 2014).

22. HYNE, *supra* note 11, at 422.

23. *See People's Gas Co.*, 31 N.E. at 59; Owen L. Anderson, *Lord Coke, the Restatement, and Modern Subsurface Trespass Law*, 6 TEX. J. OIL, GAS & ENERGY L. 203, 216 n.84 (2011).

24. Laura H. Burney & Norman J. Hyne, *Hydraulic Fracturing: Stimulating Your Well or Trespassing?*, *in* PROCEEDINGS OF THE ROCKY MOUNTAIN MINERAL LAW FORTY-FOURTH ANNUAL INSTITUTE § 19.02[3][a] (1998).

25. OFFICE OF LEGACY MGMT., U.S. DEP'T OF ENERGY, NEVADA OFFSITES FACT SHEET (2013), *available at* energy.gov/sites/prod/files/2013/08/f2/NVO_FactSheet.pdf.

26. *Id.*

27. *Id.*

28. Milo D. Nordyke, *The Soviet Program for Peaceful Uses of Nuclear Explosions*, 7 SCI. & GLOBAL SEC. 1, 33 (1998), *available at* http://scienceandglobalsecurity.org/archive/sgs07nordyke.pdf.

29. *See, e.g.*, OFFICE OF LEGACY MGMT., U.S. DEP'T OF ENERGY, RIO BLANCO, COLORADO, SITE FACT SHEET (2011), *available at* http://www.lm.doe.gov/rio_blanco/Sites.aspx; OFFICE OF LEGACY MGMT., U.S. DEP'T OF ENERGY, GASBUGGY, NEW MEXICO, SITE FACT SHEET (2011), *available at* http://www.lm.doe.gov/gasbuggy/Sites.aspx; OFFICE OF LEGACY MGMT., U.S. DEP'T OF ENERGY, RULISON, COLORADO, SITE FACT SHEET (2011),

For this reason, and perhaps others, explosive fracturing using nuclear explosions never caught on.[30]

2. Hydraulic Fracturing

But in the late 1940s, the process known as "hydraulic fracturing" was commercially developed.[31] Hydraulic fracturing (sometimes called "fracing" or "fracking" or "hydrofracturing")[32] is the process of using hydraulic pressure to create fractures.[33] The process takes advantage of the fact that many rocks will fracture if exposed to sufficiently high pressure.[34] Before using hydraulic fracturing, an operator drills a well. Then, the operator (or a service company that it has hired) uses high-pressure pumps to push a fracturing fluid down the well to the formation to be fractured. There, the fluid exits the well's piping through perforations that the company previously created in that section of the well's piping. The fluid then moves into the formation, where it imposes a pressure sufficient to create fractures in the rock.[35] The fluid used to impose the hydraulic pressure that fractures the formation is typically a mixture of water,[36] proppants,[37] and various additives.[38]

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available at http://www.lm.doe.gov/rulison/Sites.aspx.

30. Reports indicated that the level of radiation was low, but it was believed that public perception would doom any effort to market such gas as long as it contained any radiation. Nordyke, *supra* note 28, at 8; *see* G.W. FRANK ET AL., ECONOMICS OF NUCLEAR GAS STIMULATION 11–12 (1970), *available at* http://www.lm.doe.gov/Rulison/Documents.aspx.

31. Thomas E. Kurth et al., *American Law and Jurisprudence on Fracking*, 47 ROCKY MTN. MIN. L. FOUND. J. 277, 279 (2010).

32. Hannah Wiseman, *Fracturing Regulation Applied*, 22 DUKE ENVTL. L. & POL'Y F. 361, 361 (2012). "Fracking" has become the shortened term most often used in the media, but "fracing" is more traditional and still is often used by persons who regularly work in the industry. *See, e.g.*, HYNE, *supra* note 11, at 423–26 (petroleum geologist using "fracing"); Christopher S. Kulander, *Environmental Effects of Petroleum Production: 2010-2011 Texas Legislative Developments*, 44 TEX. TECH. L. REV. 863, 869–77 (2012) (oil and gas law professor repeatedly using "fracing"); Bruce M. Kramer & Owen L. Anderson, *The Rule of Capture—An Oil and Gas Perspective*, 35 ENVTL. L. 899, 933–36 (2005) (two oil and gas law professors repeatedly using "fracing").

33. SHALE GAS PRIMER, *supra* note 12, at 56.

34. *Id.*

35. *See id.* at ES-4; HYNE, *supra* note 11, at 423.

36. SHALE GAS PRIMER, *supra* note 12, at 62.

37. Proppants are small granular particles. During hydraulic fracturing, the fracturing fluid carries the proppants into the newly created fractures. When the fracturing fluid is removed from the well, the proppants remain behind, propping open the fractures, which otherwise would close after the fracturing fluid is removed. Kurth et al., *supra* note 31, at 279, 283. The most common proppant is sand, though other substances, such as small ceramic spheres and sintered bauxite are sometimes used. *See* Robin Beckwith,

After the formation has been fractured, the operator or service company that is performing the fracturing turns off the high pressure pumps and allows the pressure of the formation to push the fracturing fluid back through the well and up to the surface, where this "flowback" water is recovered.[39] Typically, 30% to 70% of the fluid initially used in the fracturing process is recovered as flowback during a relatively short period, with the remainder of the fluid gradually returning to the surface along with the oil or gas produced by the well or remaining in the target formation's pore spaces.[40]

3. The Rise in Disputes Regarding Hydraulic Fracturing

Controversy regarding hydraulic fracturing has increased dramatically in the last several years. This is attributable to the relatively new and now widespread practice of using hydraulic fracturing to stimulate production of oil and gas from shale formations. Hydraulic fracturing is not new and geologists have long known that shale formations often contain oil and gas. But shale formations have such low permeability that traditionally it was not economical to produce oil and gas from such formations even with the use of hydraulic fracturing. This has changed in recent years, with the development of improved hydraulic fracturing techniques and the industry's success in combining hydraulic fracturing and *horizontal* drilling.

Traditionally, oil and gas wells have been "vertical wells."[41] Vertical wells are drilled more or less straight downward, so that the bottom of the well is more or less directly below the surface location from which the drilling is performed.[42] But by the 1930s, operators had developed "directional drilling," in which drilling may start vertically downward, before deviating to a diagonal di-

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Proppants: Where in the World, J. PETROLEUM TECH. 36–40 (Apr. 2011), http://www.spe.org/jpt/print/archives/2011/04/11ProppantShortage.pdf.

38. SHALE GAS PRIMER, *supra* note 12, at 63 (stating that additives include biocides, corrosion inhibitors, friction reducers, and viscosity adjusters).

39. Kurth et al., *supra* note 31, at 285.

40. *See* SHALE GAS PRIMER, *supra* note 12, at 66 (explaining that the "flowback" period might last several months).

41. *See* YERGIN, THE PRIZE, *supra* note 17, at 17; *cf.* HYNE, *supra* note 11, at 285–86.

42. Often, however, there is some deviation from straight vertical, even if the operator is not intending to deviate. *See* HYNE, *supra* note 11, at 285–86.

rection.[43] This is useful for situations in which the "bottom hole" location that a company wants to reach is beneath a surface location where it would be difficult or undesirable to drill.[44] Operators also developed "horizontal drilling," in which they begin drilling vertically downward, but then gradually turn the direction of drilling (at the "kickoff point")[45] until the drilling is proceeding in a horizontal direction.[46]

Horizontal drilling can have certain advantages, including the possibility of having a longer distance of the well bore exposed to the formation from which oil or gas will be produced.[47] This is an advantage because whenever an oil or gas well is completed, oil or gas does not enter the well through an opening at the very bottom or end of the well pipe. Instead, the oil or gas enters the well bore through perforations[48] that are created in the well piping with a special tool after drilling is completed.[49] If the rock formation from which oil or gas is to be produced is anywhere from fifty to two hundred feet thick in a vertical direction, then the maximum length of well pipe that could be perforated would be between fifty and two hundred feet if a vertical well is used.[50]

But a formation that is only fifty to two hundred feet thick in a vertical direction may extend for many miles in each horizontal direction.[51] Thus, if a well is drilled horizontally for a great distance through the middle of a rock formation that contains oil or gas, a much greater length of pipe can be perforated than with a vertical well.[52] The horizontal section of pipe is called the "lateral."[53] Some horizontal wells have laterals that are a mile or more in length, and a significant portion of that length is perfo-

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43. *See id.* at 285–89; *cf.* Lamont C. Larsen, *Horizontal Drafting: Why Your Form JOA May Not Be Adequate for Your Company's Horizontal Drilling Program*, 48 ROCKY MTN. MIN. L. FOUND. J. 51, 51 (2011).

44. *See* HYNE, *supra* note 11, at 289–90.

45. *See id.* at 286 (turning the direction of drilling from vertical to an angle is "kicking off the well").

46. *See* YERGIN, THE QUEST, *supra* note 14, at 17.

47. *Id.* at 330; Larsen, *supra* note 43, at 53.

48. *See* HYNE, *supra* note 11, at xl.

49. *Id.* at 344–45.

50. *See id.* at 127.

51. *Cf.* Larsen, *supra* note 43, at 53 ("Most oil and gas reservoirs are much more extensive in their horizontal dimension than in their vertical (thickness) dimension.").

52. *Id.*

53. *Id.* at 56.

rated.[54] This results in a much greater number of perforations into which oil or gas can flow, and therefore, a much higher rate of production.[55]

By improving hydraulic fracturing techniques and combining the use of hydraulic fracturing and horizontal drilling, companies have made it economical to produce oil and gas from shale formations. This has led to increased use of hydraulic fracturing, as well as larger scale operations, and it has resulted in companies drilling numerous wells in regions of the country that have not seen such high levels of oil and gas activity in several generations, if ever. In some of these areas, more skepticism regarding oil and gas activity may exist than in other parts of the country. These things, along with some vocal opposition to hydraulic fracturing, have generated more attention and more opposition to hydraulic fracturing than was ever seen before.

D. *Confusion and Disagreement Regarding the Level of Risk Associated with Hydraulic Fracturing*

Opposing sides of the public debate regarding hydraulic fracturing sometimes disagree about facts—such as how much risk is associated with hydraulic fracturing. Two things that contribute to such disagreements are: (1) confusion and lack of knowledge regarding what hydraulic fracturing is and (2) the fact that it can sometimes be challenging to determine what caused any particular instance of groundwater contamination.

1. Confusion About What Hydraulic Fracturing Is and Misuse of Terminology that Adds to the Confusion

Although fracturing has attracted significant attention, a recent study shows that most Americans still do not know much about the process.[56] This should not be surprising given that hydraulic fracturing is a complicated process that relatively few people actually engage in. But it also leads to significant confusion in the public debate about hydraulic fracturing. The lack of

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54. *See id.* at 53; HYNE, *supra* note 11, at 293.

55. *See* Larsen, *supra* note 43, at 53.

56. Hilary Boudet et al., *"Fracking" Controversy and Communication: Using National Survey Data to Understand Public Perceptions of Hydraulic Fracturing*, 65 ENERGY POL'Y 57, 58, 63 (2014).

information results in many Americans lacking an opinion regarding fracturing, but others may form an opinion even though they know little about the process.[57]

Moreover, the media sometimes contributes to the confusion. Hydraulic fracturing is just one portion of the activities involved in drilling and completing oil and gas wells. But many media stories misuse the terms "hydraulic fracturing" or "fracking" to refer to virtually any part of the oil and gas exploration and production process. For example, when almost any accident or adverse incident relating to oil and gas activity in a shale drilling area occurs, it is common to see many media sources refer to the incident as a "hydraulic fracturing" or "fracking" incident, even if the incident has little to do with hydraulic fracturing. Thus, if a blowout occurs, it is described as a "fracking" issue, not a well control issue. If a poor cement job allows contamination, it might be described as a "fracking" problem, rather than a well construction problem. If a spill of flowback or produced water occurs, it is described as a "fracking" problem, rather than a waste handling problem. And if authorities conclude that an injection disposal well induced seismic activity, at least a few headlines or news stories likely will erroneously suggest that the seismic activity may have been caused by "fracking," as opposed to an injection disposal well. While each of these types of incidents is a problem that merits discussion, they are not hydraulic fracturing problems. The erroneous use of the terms "hydraulic fracturing" and "fracking" to describe almost any aspect of oil and gas activity adds to the public confusion and distorts views regarding the risks associated with hydraulic fracturing.

This issue cannot be directly addressed by baseline testing, the primary topic of this article, but the distinction between hydraulic fracturing and the remainder of the oil and gas drilling process is important to note here for at least two reasons. First, it provides perspective on the public confusion regarding fracturing and serves as a reminder that baseline testing only addresses certain causes of confusion and disagreement regarding hydraulic fracturing. Second, as will be noted later in this article, states that enact laws requiring or encouraging baseline testing will have to decide whether to require baseline testing before the drill-

57. *Id.* at 63.

ing of any oil and gas well, or only before the drilling of a well that will be hydraulically fractured.

2. Challenges in Determining the Cause of Groundwater Contamination

A second reason that people on opposite sides of the fracturing debate can disagree about facts—such as the level of risk associated with fracturing—is that it can be difficult to determine the cause of particular incidents of alleged groundwater contamination. A couple of reasons this can be challenging are that: (1) often there are multiple potential causes of contamination and (2) a lack of baseline water quality data may make it difficult to know when the contamination first appeared.

a. Multiple Potential Causes of Contamination

Often, sampling and analysis is needed to prove whether water is contaminated.[58] Further, even if testing shows that groundwater is contaminated, there will often be multiple potential causes of the contamination. Some harmful substances are found naturally in the groundwater in certain areas.[59] Also, some types of contamination can be a result of any one of several sorts of human activity.[60] Further, in some cases, several different persons or companies might have engaged independently in the types of activity that can cause contamination.

Methane, which is the principal component of natural gas, serves as an example.[61] In several of the disputes in which land-

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58. ELIZABETH W. BOYER ET AL., CTR. FOR RURAL PA., THE IMPACT OF MARCELLUS GAS DRILLING ON RURAL DRINKING WATER SUPPLIES 4, 6 (2012), *available at* http://www.marcellus.psu.edu/resources/PDFs/swistock_water.pdf.

59. *See, e.g.*, MARTHA G. NIELSEN ET AL., U.S. GEOLOGICAL SURVEY, SCIENTIFIC INVESTIGATIONS REPORT 2010-5199, ASSESSMENT OF ARSENIC CONCENTRATIONS IN DOMESTIC WELL WATER, BY TOWN, IN MAINE, 2005–09, at 1 (2010), *available at* http://pubs.usgs.gov/sir/2010/5199/pdf/sir2010-5199_nielsen_arsenic_report_508.pdf (noting that arsenic is found naturally in the groundwater in some areas).

60. *See, e.g.*, *id.* (noting use of arsenic as a pesticide on crops); M.V. MATHES & J.S. WHITE, U.S. GEOLOGICAL SURVEY, METHANE IN WEST VIRGINIA GROUND WATER (2006), *available at* http://pubs.usgs.gov/fs/2006/3011/pdf/Factsheet2006_3011.pdf (noting multiple human activities that can cause methane to be present in groundwater).

61. HYNE, *supra* note 11, at 10 (natural gas is typically 70% to 98% methane); SPEIGHT, *supra* note 7, at 782 (same).

owners allege that hydraulic fracturing caused groundwater contamination, the alleged contaminant is methane.[62]

Several different things can cause methane contamination. First, there are many locations in which the groundwater naturally contains methane. A recent U.S. Geological Survey report regarding the presence of methane in New York groundwater illustrates this point.[63] The report states that, "[m]ethane naturally discharges to the land surface at some locations in New York."[64] The report describes the locations of "several surface seeps of natural gas" in New York, and notes: "Methane occurs locally in the groundwater of New York; as a result it may be present in drinking-water wells, in the water produced from those wells, and in the associated water-supply systems."[65] Other recent reports from other sources have noted the widespread natural occurrence of methane in water wells in upstate New York and parts of Pennsylvania.[66] Still other studies have found naturally occurring methane in groundwater in other areas.[67]

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62. *See, e.g.*, Roth v. Cabot Oil & Gas Corp., 287 F.R.D. 293, 295 (M.D. Pa. 2012).

63. WILLIAM M. KAPPEL & ELIZABETH A. NYSTROM, U.S. GEOLOGICAL SURVEY, DISSOLVED METHANE IN NEW YORK GROUNDWATER 1 (2012), *available at* http://pubs.usgs.gov/of/2012/1162/pdf/ofr2012-1162_508_09072012.pdf.

64. *Id.*

65. *Id.*

66. One recent study of methane in water wells in northeastern Pennsylvania and upstate New York concluded that average methane concentrations in water wells were higher in wells located in the vicinity of oil and gas activity, though the study noted that a large portion of drinking water wells contained methane "regardless of gas industry operations," and that "[p]revious studies have shown . . . naturally occurring methane in shallow aquifers." Stephen G. Osborn et al., *Methane Contamination of Drinking Water Accompanying Gas-Well Drilling and Hydraulic Fracturing*, 108 PROC. NAT'L ACAD. SCI. 8172, 8173, 8175 (2011). The authors of that study, the "Duke Study," conclude that natural gas exploration and production activities are the likely cause of the elevated methane concentrations, though they speculated that poorly constructed, leaking wells were more likely the cause of methane contamination, rather than migration of methane from the formations being fractured upward through the formations above. *Id.* at 8175.

The authors of another recent report disagreed with the Duke Study, concluding that the data show no correlation between the level of methane in water wells and the proximity of oil and gas activity. Those authors stated that methane occurs naturally in many water wells in Susquehanna County, Pennsylvania. Lisa J. Molofsky et al., *Methane in Pennsylvania Water Wells Unrelated to Marcellus Shale Fracturing*, OIL & GAS J., Dec. 5, 2011, at 54, *available at* http://www.cabotog.com/pdfs/MethaneUnrelatedtoFracturing.pdf.

67. TIMOTHY M. KRESSE ET AL., U.S. GEOLOGICAL SURVEY, U.S. DEP'T OF THE INTERIOR, SHALLOW GROUNDWATER QUALITY AND GEOCHEMISTRY IN THE FAYETTEVILLE SHALE GAS-PRODUCTION AREA, NORTH-CENTRAL ARKANSAS, 2011, at 27 (2012), *available at* http://pubs.usgs.gov/sir/2012/5273/sir2012-5273.pdf; U.S. GEOLOGICAL SURVEY, OVERVIEW OF GROUNDWATER QUALITY IN THE PICEANCE BASIN, WESTERN COLORADO, 1946–2009, at 40 (2013), *available at* http://pubs.usgs.gov/sir/2012/5198/SIR12-5198.pdf;

Further, several types of human activity can cause methane contamination of groundwater, including coal mining,[68] oil and gas activity,[69] and other human activities (such as landfill operations).[70] Additionally, there might be more than one company that has been involved in such activities in a particular area. This does not necessarily make it impossible to determine the source of methane contamination, but it can complicate the task of determining the source.

b. The Absence of Baseline Water Quality Data May Make It Impossible to Determine When Contamination First Appeared

Another reason that proving the cause of contamination can be challenging is that landowners rarely have data to show what the quality of their groundwater was in the past.[71] The absence of such "baseline data" can be a problem because it may prevent the landowner from proving when, or even approximately when, the contamination first appeared.

Assume, for example, that a landowner discovers that his groundwater contains methane. If the landowner does not have past baseline data, he obviously will not have any test data to show that his groundwater was free of methane at some prior time. Further, lay testimony will not necessarily be able to establish when the contamination occurred because methane is odorless and tasteless, and the existence of methane contamination might not be readily apparent.

Being able to prove approximately when contamination first appeared is helpful in determining what caused the contamination, but it is not enough to prove causation. For example, it could help rule out as potential causes activities that did not occur until after the contamination appeared. For investigators seeking to determine the cause of contamination, it could also give them a

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MATHES & WHITE, *supra* note 60. Experts can attempt to determine the source of the methane by examining the hydrogen and carbon isotopes in the methane, and by analyzing what other hydrocarbons are present. This is discussed in both the Osborn study (the Duke Study) and the Molofsky Study discussed *supra* note 66.

68. MATHES & WHITE, *supra* note 60.

69. *Id.*

70. *Id.*

71. David Biello, *Fracking Can Be Done Safely, But Will It Be?*, SCI. AM. (May 17, 2013), http://www.scientificamerican.com/article/can-fracking-be-done-without-impacting-water/.

clue regarding the activities on which to focus their investigations—perhaps activities that occurred a relatively short time before the first appearance of the contamination, but long enough before that contamination had sufficient time to migrate to the contaminated water supply.

For example, suppose that a particular person's groundwater is currently contaminated with methane and past baseline testing data shows that a similar level of methane contamination existed prior to recent hydraulic fracturing activity. That baseline data would be fairly conclusive evidence that the fracturing operation was not to blame for the contamination. On the other hand, if baseline testing data showed that the methane concentration a few weeks prior to fracturing was much lower than the methane concentration a short time after fracturing, that is circumstantial evidence that the fracturing operation (or, more likely, some other aspect of drilling and completing the hydraulically fractured well) might have caused the contamination. Such circumstantial evidence would not be conclusive proof of what caused the contamination, but it could be one piece of evidence, and it could be a clue (assuming that there was no other recent activity that was a likely cause of contamination) that persons seeking to determine the cause should focus their investigations on the oil and gas activity.[72]

In short, the absence of baseline data may make it more difficult to determine the cause of contamination. That can be unfortunate for a landowner who seeks to determine the cause of groundwater contamination and, if the cause is human activity rather than natural causes, to hold the responsible individuals liable. It can also be unfortunate for a defendant who is sued for contamination that he believes he did not cause. And in addition to (and perhaps more important than) the misfortune befalling the individuals involved in a given dispute, uncertainty about the causes of contamination can make it more difficult for policymakers and the public to make informed judgments regarding what policies and regulations are appropriate.

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72. *See, e.g.*, Jarrett Skorup, *Experts: Earthquakes, Water Usage Not Concerns with Fracking in Michigan*, MICHIGAN CAPITOL CONFIDENTIAL (Aug. 22, 2013), http://www.michigancapitolconfidential.com/18998. If a contaminant was a man-made substance not used in fracturing or other aspects of oil and gas activity, the most reasonable conclusion would be that the contamination was caused by some activity other than the activities of the oil and gas company.

E. *Baseline Testing*

The widespread use of groundwater baseline testing would have several benefits. It would help avoid or resolve disputes regarding the cause of groundwater contamination. Also, the data obtained from such testing would shed light on the level of risk associated with oil and gas activity, including hydraulic fracturing. If such data were made public, it could lead to more informed public policy and regulatory decisions.[73]

II. POTENTIAL WAYS TO PROMPT BASELINE TESTING

Baseline testing of groundwater would have several benefits. Some states, such as California, Colorado, Ohio, and Wyoming, have enacted laws that require baseline testing. Other states, such as Pennsylvania and West Virginia, have enacted "presumptions" that encourage baseline testing. At least one state, Illinois, has done both. Below, this article discusses issues relating to these state laws that: (1) require baseline testing or (2) create presumptions that encourage baseline testing.

A. *Requiring Baseline Testing*

One way to promote the use of baseline testing is to require such testing. Baseline testing would have the benefits noted above, which include helping to avoid or resolve individual disputes regarding groundwater contamination. Perhaps a more important benefit is that the data provided by baseline testing could lead to more informed public debate, policy making, and rulemaking. In recent years, hydraulic fracturing has become controversial, in large part because many people fear that the process causes groundwater contamination. The available evidence suggests that this very rarely happens and that the fear of fracturing

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73. The two benefits noted above are the benefits most relevant to deciding whether states should require or encourage baseline testing prior to oil and gas activity, but there are other benefits. For example, baseline testing could help alert landowners to existing water quality problems. Past studies have shown that a significant number of private water wells have contamination problems, even if there has not been oil and gas activity nearby, and landowners often are unaware of those water quality deficiencies. Finally, in addition to helping educate the public and policymakers regarding whether particular activities frequently cause contamination, a baseline testing program could increase the amount of publicly available information about groundwater quality, which could be beneficial for a number of reasons.

is overblown.[74] If data acquired from baseline testing help confirm that hydraulic fracturing rarely causes contamination, that might help avoid the enactment of undue restrictions on hydraulic fracturing and ease unwarranted fears.

On the other hand, if the data show that hydraulic fracturing causes problems more frequently than the currently available evidence would suggest, the availability of that data could be useful in building support for any additional regulations that are appropriate. Further, the mere fact that baseline testing is required by law could lead to more public confidence in oil and gas development and existing regulatory programs.

These reasons provide strong justifications for enacting regulations to require baseline testing, but are there countervailing reasons not to require testing? If a particular mandatory testing requirement was too costly, impractical for other reasons, or unfair, those would be sound reasons to oppose it, but a mandatory testing requirement need not be any of those things.

Conducting baseline testing adds to the expense of operations, but evidence suggests that the expense is not so high as to make such testing cost-prohibitive. Some of this "evidence" includes the fact that baseline testing has been endorsed by certain industry organizations. For example, the American Petroleum Institute ("API")[75] published a guidance document recommending that operators conduct baseline testing prior to drilling a well that will be hydraulically fractured.[76] The Canadian Association of Petroleum Producers ("CAPP") also suggests that operators conduct baseline testing prior to drilling wells that will be hydraulically fractured.[77]

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74. The lack of evidence to support fears that hydraulic fracturing poses a significant risk to groundwater quality is discussed in Part II.B.3.b. *See, e.g.*, Skorup, *supra* note 72.

75. In recent comments to proposed regulations, an API representative stated: "API is a national trade association representing over 500 member companies involved in all aspects of the oil and natural gas industry. API's members include producers, refiners, suppliers, pipeline operators, and marine transporters, as well as service and supply companies that support all segments of the industry." Letter from Erik Milito, Group Director, Upstream & Indus. Operations, Am. Petroleum Inst., to U.S. Dep't of the Interior, Director (630), Bureau of Land Mgmt. 1 (Aug. 23, 2013), *available at* http://www.api.org/~/media/Files/News/2013/13-August/API%20comments%20BLM.pdf.

76. AM. PETROLEUM INST., API GUIDANCE DOCUMENT HF1, HYDRAULIC FRACTURING OPERATIONS—WELL CONSTRUCTION AND INTEGRITY GUIDELINES 20 (2009), *available at* http://www.api.org/~/media/Files/Policy/Exploration/API_HF1.pdf.

77. CANADIAN ASS'N OF PETROLEUM PRODUCERS, CAPP HYDRAULIC FRACTURING

During the public comment period for Wyoming's baseline testing rule, one major oil company sent a letter to regulators supporting many aspects of the proposed regulation, including the requirements for testing prior to any drilling for oil or gas (whether or not the well will be hydraulically fractured).[78] Another company expressed opposition to certain portions of the proposed Wyoming regulation, including the requirement for *post*-drilling testing, but the company did not express opposition to mandatory *pre*-drilling testing.[79] Indeed, the company stated that it had implemented a policy of conducting pre-drilling testing several years before.[80] In addition to those industry organizations, the Center for Sustainable Shale Development, a group that includes both environmentalist and industry stakeholders, developed best practices recommendations that call for baseline testing.[81]

Further, anecdotal reports suggest that many exploration and production companies are voluntarily conducting baseline testing in some states that do not require such testing. For example, during a telephone interview with the author, an API representative stated that it is her understanding that most or all of API's members attempt to conduct baseline testing before conducting hydraulic fracturing operations.[82] In another interview with the author, the vice president of an analytical laboratory in Wyoming stated that the lab has received a significant number of samples from companies that voluntarily conducted pre-drilling baseline testing.[83] These examples strongly suggest that baseline testing programs are already widely used and are not unduly costly.

OPERATING PRACTICE: BASELINE GROUNDWATER TESTING 1 (2012), *available at* http://www.capp.ca/getdoc.aspx?DocID=218135&DT=NTV.

78. Letter from Michael L. Bergstrom, Onshore Sci. & Regulatory Advisor, Shell Exploration & Prod. Co., to State of Wyo., Wyo. Oil & Gas Conservation Comm'n (Oct. 11, 2013) (on file with author).

79. Letter from Michael A. Williams, Senior Envtl. Prof'l, Marathon Oil, to Grant Black, Supervisor, Wyo. Oil & Gas Conservation Comm'n (Oct. 7, 2013) (on file with author).

80. *Id.*

81. CTR. FOR SUSTAINABLE SHALE DEV., PERFORMANCE STANDARDS 3 (2013), *available at* https://www.sustainableshale.org/wp-content/uploads/2014/01/Performance-Standards-v.-1.1.pdf.

82. Interview with Stephanie Meadows, Senior Pol'y Advisor, Am. Petroleum Inst. (Dec. 16, 2013).

83. Interview with vice president of analytical lab (Jan. 6, 2014).

So what is the approximate cost of conducting baseline testing? That depends on a variety of circumstances, including the number of water sources that must be sampled and the particular analytes for which testing is performed.[84] As an example, consider the costs to test for the analytes required under the Wyoming regulation. The Petroleum Association of Wyoming estimated, based on price quotes from analytical labs, that costs for analysis run between $680 and $1091 per sample, assuming that isotopic testing of methane is not required (it is required if methane concentration exceeds a certain level).[85] Isotopic testing would add about $550 for each sample that required such testing.[86]

The costs of identifying the sample locations and actually collecting the samples would be an additional expense. The Association estimated that, if samples were collected from four water wells, the costs of the initial sampling and analyses would be $5800, if isotopic testing of methane was not required.[87]

Assuming that it is not necessary to collect and analyze a large number of samples, these cost estimates indicate that baseline testing is not cost prohibitive, if one assumes that the testing is done for a horizontal well that will be drilled to a deep shale formation and fractured. The costs of drilling and completing such wells can be several million dollars, so the costs of testing would be only a small portion of total costs. Of course, given that shallow vertical wells that will not be hydraulically fractured can be significantly less expensive, it would be easier in those cases for the costs of sampling and testing to adversely impact the economics of drilling. Further, even for deep horizontal wells that will be hydraulically fractured, the costs of testing might be more problematic if numerous samples had to be collected and analyzed.

Thus, if a baseline testing rule required the collection and analyses of too many samples, the requirement might become im-

84. An analyte is "the specific component that is being measured in a chemical analysis." MCGRAW-HILL DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS 88 (Sybil P. Parker ed., 5th ed. 1994).

85. Comments Regarding Proposed Rule Changes to Chapters 1, 3, and Appendix K from John Robitaille, Vice President, Petroleum Ass'n of Wyo., to Wyo. Oil & Gas Conservation Comm'n (Oct. 11, 2013) (regarding proposed baseline testing regulation).

86. *Id.*

87. *Id.* The Wyoming regulation also requires two rounds of post-drilling sampling and testing. That round of sample collection and testing would each cost a little less (one source estimated about 17% less) because the costs of identifying wells to be sampled would already have been done. *Id.*

practically costly. But states should be able to address this potential problem by drafting the baseline testing regulation so that an excessive number of samples will not be necessary. Indeed, as noted below, some states appear to have drafted their laws to avoid the problem of excessive costs. Thus, costs need not stand in the way of requiring baseline testing.

Requiring baseline testing could result in some delays. The oil and gas operator will need to determine what water supplies need to be sampled, seek permission to collect samples, schedule and perform the sample collection, and then have a certified laboratory analyze the results. These tasks could take several weeks—just obtaining analytical results after samples have been delivered to a lab can take a month. But there are also other time consuming tasks that must precede drilling, and states should be able to structure baseline testing programs so that delay does not become a major problem. Indeed, delay did not seem to be an issue in the industry responses to Wyoming's proposed regulations.

Finally, mandatory baseline testing does not seem unfair to the industry. It is sound policy to impose reasonable requirements for environmental protection, and for monitoring potential environmental impacts. Further, baseline testing seems reasonable. A baseline testing program could be unfair if it required the collection and testing of so many samples that the testing became cost prohibitive, or if the program required testing for numerous substances wholly unrelated to oil and gas activity, but these are mere theoretical possibilities. The baseline testing programs implemented so far do not seem to require a cost prohibitive amount of testing.

Accordingly, there is no compelling reason why states should not require baseline testing prior to hydraulic fracturing. Given the absence of any such reason, states should require testing.[88]

88. The United States Secretary of Energy appointed an advisory board to examine shale gas development issues. *See* Memorandum from Steven Chu to William J. Perry, Chairman, Sec'y of Energy Advisory Bd. (May 5, 2011), *available at* http://energy.gov/sites/prod/files/edg/news/documents/Fracking_subcommittee_charge.pdf. That group issued a report that included various recommendations, including a recommendation for baseline testing. SHALE GAS PROD. SUBCOMM., DEP'T OF ENERGY, SECOND NINETY DAY REPORT 7 (2011), *available at* http://www.shalegas.energy.gov/resources/111811_final_report.pdf.

B. *Presumptions*

Another way that states could promote baseline testing is by creating "presumptions" that encourage such testing.

1. The Types of "Presumptions"

In law, the word "presumption" is used to describe at least three distinct concepts—namely: (1) evidentiary presumptions, (2) irrebuttable presumptions, and (3) an allocation of the burden of proof[89]—and states have used at least two of the three types of presumptions to encourage testing.

a. Evidentiary Presumptions

The first type of presumption, an "evidentiary presumption," is a *rebuttable* conclusion of fact that the law requires the factfinder to accept if some other "predicate fact" is proven and the presumption is not rebutted.[90] Evidentiary presumptions have been described as follows:

> An evidentiary presumption is an inference that the law requires the trier of fact to draw, if [the factfinder] finds the existence of a "predicate fact," unless the presumption is rebutted. An example of an evidentiary presumption is the [Louisiana] Civil Code's provision that the husband of the mother is presumed to be the father of all children born during the marriage. If little Johnny's mother proves that big John was her husband during the appropriate time (the predicate fact), the trier of fact must infer that big John is the father (the required inference), even if there is no actual evidence of paternity, unless the presumption of paternity is rebutted.[91]

What it takes to rebut an evidentiary presumption can vary by jurisdiction. In some jurisdictions, the presumption is not rebutted unless a party introduces evidence that persuades the trier of fact that the presumption is not true.[92] But in other jurisdictions,

89. *See* Keith B. Hall, *Evidentiary Presumptions*, 72 TUL. L. REV. 1321, 1321–23 (1998).

90. *See, e.g.*, LA. CODE EVID. ANN. art. 302 (Westlaw through 2013 Reg. Sess.); Hall, *supra* note 89, at 1321–23.

91. Hall, *supra* note 89, at 1321–22 (footnotes omitted).

92. *See, e.g.*, LA. CODE EVID. ANN. art. 305 (Westlaw through 2013 Reg. Sess.); *id.* art. 306 (Westlaw through 2013 Reg. Sess.).

so-called "bursting bubble" evidentiary presumptions are used.[93] If an evidentiary presumption is a bursting-bubble presumption, it is rebutted if a party presents virtually any evidence whatsoever that the presumption is incorrect.[94] Effectively, such presumptions apply only if there is no direct evidence on a subject.

b. Irrebuttable Presumptions

The second type of presumption, an "irrebuttable presumption," is a conclusive presumption that cannot be rebutted.[95] Because irrebuttable presumptions are conclusive, they are rules of substantive law.[96] For example, if a state has a conclusive presumption that someone under a certain age cannot have criminal intent, that "presumption" is a substantive rule that persons under that age bear no criminal responsibility.[97]

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93. *See* Hall, *supra* note 89, at 1327. The burden of proof on an issue can be divided into two parts—the burden of production and the burden of persuasion. *Id.* at 1323. If a party has the burden of production on an issue, that party's opponent will prevail on the issue if the party with the burden of production fails to produce any evidence on the issue. *Id.* Assuming at least some evidence is produced, the burden of production is met and the burden of persuasion becomes relevant. If a party bears the burden of persuasion (and at least some evidence has been produced), the party's opponent will prevail on an issue unless the party with the burden of persuasion convinces the factfinder with respect to that issue (with a preponderance of the evidence being the typical level of proof required in a civil case). *Id.* at 1323–24.

Many commentators and courts have concluded that the only effect of presumptions under federal law is to put the burden of initially producing some evidence on the party that opposes a presumption, and that once some evidence is produced, the presumption is deemed to be rebutted. *Id.* at 1327. Those commentators and courts believe that, unlike Louisiana law, the federal rule does not shift the burden of persuasion. *Id.* Instead, the rule establishes a "bursting bubble" presumption that disappears and has no further effect once some evidence is presented to rebut the presumption. *Id.*

94. *Id.*

95. *See id.* at 1322–23.

96. *See* B & G Constr. Co. v. Dir., Office of Workers' Comp. Programs, 662 F.3d 233, 254 (3d Cir. 2011) (finding that a statute creating any "irrebuttable presumption" sets forth a rule of "substantive law"); United States v. Chase, 18 F.3d 1166, 1172 n.7 (4th Cir. 1994); Fed. Deposit Ins. Corp. v. Superior Court, 62 Cal. Rptr. 2d 713, 718 (Cal. Ct. App. 1997) (stating that a conclusive presumption is not a rule of evidence but a substantive rule of law); *see also* 2 MCCORMICK ON EVIDENCE § 342, at 451 (John William Strong ed., 4th ed. 1992) (suggesting that courts apply a rule of law when they use a conclusive presumption); 21B CHARLES ALLAN WRIGHT & KENNETH W. GRAHAM, JR., FEDERAL PRACTICE AND PROCEDURE § 5124, at 494 (2d ed. 2005) (noting that "most knowledgeable judges and lawyers understand that 'conclusive presumptions' are simply fictions in which a rule of substantive law comes disguised as a presumption").

97. Hall, *supra* note 89, at 1322–23. Louisiana Revised Statute section 14:13 "exempt[s]" persons under ten years of age from criminal liability. LA. REV. STAT. ANN. § 14:13 (Westlaw through 2013 Reg. Sess.) The Louisiana statute "sounds" substantive and

c. Allocations of the Burden of Proof

Finally, "presumption" sometimes is used to describe an allocation of the burden of proof.[98] For example, the "presumption of innocence" is a shorthand way of stating that the prosecutor has the burden of proof in a criminal trial.

2. How States Use Presumptions to Encourage Baseline Testing

States have used two types of presumptions that give companies an incentive to perform baseline testing. For example, Pennsylvania law does not require baseline testing, but a Pennsylvania statute creates presumptions that encourage it.[99] The statute provides that, if a groundwater supply located within 2500 feet of the vertical section[100] of an unconventional oil or gas well[101] becomes contaminated within twelve months after completion or hydraulic fracturing of the well, there is a "rebuttable presump-

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clearly is a rule of substantive law. The common law had a similar substantive rule that courts characterized as a conclusive "presumption" that a child under seven years of age could not be liable for a crime. State v. Wood, 931 A.2d 1008, 1010 (Del. Fam. Ct. 2007); *see* Andrew Walkover, *The Infancy Defense in the New Juvenile Court*, 31 UCLA L. REV. 503, 510 (1984).

98. Hall, *supra* note 89, at 1323; *see* 1 MICHAEL H. GRAHAM, HANDBOOK OF FEDERAL EVIDENCE § 301.6 (6th ed. 2006); 2 MCCORMICK ON EVIDENCE, *supra* note 96, § 342, at 453.

99. *See* 58 PA. CONS. STAT. ANN. § 3218(c) (West Cum. Supp. 2013).

100. Many of the oil and gas wells drilled into shale formations—a classic unconventional formation—are drilled vertically downward until drilling nearly reaches the desired depth, then the direction of drilling is gradually turned from vertical to horizontal, with the drilling then proceeding horizontally for perhaps a mile or more within the shale formation. Hannah Wiseman, *Regulatory Adaptation in Fractured Appalachia*, 21 VILL. ENVTL. L.J. 229, 236–37 (2010); *see also* Keith B. Hall, *Regulation of Hydraulic Fracturing Under the Safe Drinking Water Act*, 19 BUFF. ENVTL. L.J. 1, 7–8 (2011). "Shale gas" is natural gas produced from a shale formation. *Glossary*, U.S. ENERGY INFO. ADMIN. [hereinafter EIA GLOSSARY], http://www.eia.gov/tools/glossary/index.cfm?id (last visited Feb. 18, 2014).

101. The Energy Information Administration's glossary of terms defines "[u]nconventional oil and natural gas production" as "[a]n umbrella term for oil and natural gas that is produced by means that do not meet the criteria for conventional production." EIA GLOSSARY, *supra* note 100. In turn, it defines "[c]onventional oil and natural gas production" as production from "a well drilled into a geologic formation in which the reservoir and fluid characteristics permit the oil and natural gas to readily flow to the wellbore." *Id.* Hydraulic fracturing often is used in unconventional formations. THOMAS E. KURTH ET AL., AMERICAN LAW AND JURISPRUDENCE ON FRACING—2011, at 4 (2011), *available at* http://www.energyfromshale.org/sites/default/files/Fracking-Study-2011-Updated-Version-08-22-2011.pdf ("Hydraulic fracturing is generally viewed as a completion technique that is a practical necessity to promote development of unconventional 'tight' shale reservoirs, particularly gas-shale.").

tion" that the oil and gas operations caused the contamination.[102] A similar rebuttable presumption applies for conventional wells, though it applies for a smaller area and for a shorter period of time than the presumption for unconventional wells.[103]

An operator can rebut the presumption that he caused the contamination by "affirmatively prov[ing]" that something else caused the contamination,[104] or by showing that the owner of the water supply refused to allow the operator to sample the water.[105] But the Pennsylvania statute also states that "[a]ny operator electing to preserve its defenses [based on rebutting the presumption] shall retain the services of an independent certified laboratory to conduct the predrilling . . . survey of water supplies," and shall provide the survey results to state regulators and the owner of the water supply that is sampled.[106] This provision arguably creates an irrebuttable presumption that applies in the event

102. 58 PA. CONS. STAT. ANN. § 3218(c)(2). For unconventional wells, the statute provides that the rebuttable presumption will apply if contamination occurs within twelve months after completion or "stimulation" of the well. *Id.* Hydraulic fracturing is a form of "well stimulation." The Manual of Oil and Gas Terms does not define "well stimulation," but it notes that "stimulate" is defined by a West Virginia statute as "any action taken by well operator to increase the inherent productivity of an oil or gas well including, but not limited to, fracturing, shooting or acidizing, but excluding cleaning out, bailing or workover operations." WILLIAMS & MEYERS, *supra* note 12, at 1034 (quoting W. VA. CODE § 22-4-1(u) (Cum. Supp. 1980)).

103. 58 PA. CONS. STAT. ANN. § 3218(c)(1). For a conventional oil and gas well (one that is not hydraulically fractured), the rebuttable presumption applies whenever a water supply located within 1000 feet of the well becomes contaminated within six months of completion of the well. *Id.*

104. *Id.* § 3218(d). The operator also can rebut the presumption by proving that the contaminated water supply is located outside the area for which the presumption is established, that the contamination occurred either before the operator's drilling activity or after the time period for which the presumption applies, or that "the landowner or water purveyor refused to allow the operator access to conduct a predrilling . . . survey." *Id.*

If the defendant rebuts the presumption by proving that something other than his operations caused the contamination, that proof probably will be sufficient to defeat liability. If, on the other hand, the defendant rebutted the presumption by proving that the contamination occurred after the time period for which the presumption applies or that the owner of the water refused to allow the operator to sample the water, a court might allow the owner of the water supply to attempt to prove (without the aid of a rebuttable presumption) that the operator caused the contamination.

105. *Id.* § 3218(e.1). The statute requires the operator to inform the landowner that he will lose the benefit of the rebuttable presumption if he refuses to grant the operator access to perform a predrilling survey. *Id.*

106. *Id.* § 3218(e). The regulation does not specify the chemicals for which an operator should test, but given the rebuttable presumption established by the statute, operators have an incentive to conduct a reasonably thorough analysis.

that the operator does not perform the required baseline testing.[107]

The West Virginia Horizontal Well Act[108] contains somewhat similar provisions that apply to "horizontal" oil and gas wells.[109] The Act provides that if a water supply located within 1500 feet of the vertical section of a horizontal well becomes contaminated within six months of completion of the well there is a rebuttable presumption that the operator of the oil and gas well caused the contamination.[110] The operator of the well can rebut the presumption, but if the operator wishes to rebut it by proving that the "pollution existed prior to the drilling," he must perform baseline testing.[111]

Most states that require testing do not create evidentiary presumptions that hydraulic fracturing causes contamination,[112] but Illinois has enacted legislation that requires baseline testing, and the legislation also creates a rebuttable presumption.[113] The Illinois statute provides that, if pre-fracturing baseline testing of a water supply within 1500 feet of a hydraulically fractured well did not show the existence of contamination, there will be a pre-

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107. Perhaps a court would interpret this language as merely precatory. Otherwise, this provision could lead to unjust results. Assume, for example, that an operator did not perform the required baseline testing using an independent laboratory, but there is irrefutable evidence that something else caused the contamination. It would be unfair in such a situation to impose an irrebuttable presumption that the operator caused the contamination.

108. W. VA. CODE ANN. §§ 22-6A-1 to -24 (LexisNexis Supp. 2013).

109. *See supra* notes 45–46 for a description of horizontal drilling.

110. W. VA. CODE ANN. § 22-6A-18(b) (LexisNexis Supp. 2013).

111. *Id.* § 22-6A-18(c). Under the West Virginia Horizontal Well Act, an operator's failure to perform baseline testing does not appear to preclude the operator from rebutting the presumption altogether, as the Pennsylvania statute arguably does.

112. Colorado's regulation expressly states that "sampling results, . . . including any changes in the constituents or concentrations of constituents present in the samples, shall not create a presumption of liability, fault, or causation against the owner or operator of a Well." COLO. CODE REGS. § 404-1:609(g) (2014). Wyoming's regulations also expressly state that the sampling and test results do not establish a presumption in favor of or against liability, and that the admissibility of the test results as evidence will be governed by the generally applicable administrative or evidentiary rules that apply in a proceeding in which a party seeks to use the results. WYO. CODE R. (Oil & Gas Conservation Comm'n), ch. 3 § 46(m) (2014). Ohio's statute does not provide for an evidentiary presumption. OHIO REV. CODE ANN. § 1509.06 (LexisNexis Repl. Vol. 2013). California's statute does not appear to create any evidentiary presumptions. *See* CAL. PUB. RES. CODE § 3160 (West Cum. Supp. 2014) (containing no language indicating an evidentiary presumption of any kind).

113. *Illinois Passes Comprehensive Hydraulic Fracturing Legislation*, VINSON & ELKINS, http://www.velaw.com/uploadedfiles/VEsite/Resources/IllinoisPassesComprehensiveHydraulicFracturingLegislation.pdf (last visited Feb. 18, 2014).

sumption that the fracturing operation is the cause of any contamination that appears within thirty months of the fracturing.[114] The statute goes on to state that in order to rebut the presumption, the defendant must establish "by clear and convincing evidence" that the contamination resulted from some "identifiable cause other than the high volume hydraulic fracturing operations."[115]

3. Evidence Suggests that Some Common Justifications for Rebuttable Presumptions Are Not Present

In the discussion above, this article concluded that states should require baseline testing of groundwater prior to hydraulic fracturing. An alternative approach would be to create rebuttable presumptions that encourage testing, rather than laws that require testing. But the most direct way to increase the use of testing is to require it. And, for the reasons noted above, public policy favors the widespread use of baseline testing.

But this leads to the question, should states use rebuttable presumptions as an additional encouragement to conduct baseline testing as Illinois does? A consideration of this question demonstrates that there are reasons that a rebuttable presumption should not be used.

The law's use of rebuttable presumptions is somewhat rare. Although it is possible to compile a reasonably long list of rebuttable presumptions, the number of such presumptions is extremely small compared to the almost limitless number of factual circumstances in which rebuttable presumptions do not apply. The almost universal rule is that the party advancing a proposition has the burden of proof. Thus, a plaintiff typically must prove his or her case, even in complex cases, without the assistance of evidentiary presumptions.

114. 225 ILL. COMP. STAT. ANN. 732/1-85 (Westlaw through P.A. 98-626 of the 2013 Reg. Sess.).

115. *Id.* 732/1-85(c)(3). This significantly and harshly tilts the table against oil and gas operators, and does so in multiple ways. Not only does it impose a rebuttable presumption, but it also provides that the defendant needs clear and convincing evidence, not just a preponderance of the evidence, to rebut the presumption. Finally, the statute suggests that it will not be sufficient for the defendant to prove by clear and convincing evidence that his operations did not cause the contamination. Instead, he must also prove—apparently by clear and convincing evidence—the identity of the actual cause of the contamination.

Further, a rebuttable presumption that hydraulic fracturing is the cause of contamination does not share certain characteristics that are commonly found in the rebuttable presumptions that are recognized by the law. For example, common characteristics of rebuttable presumptions include: (1) the evidence necessary to rebut a presumption is uniquely within the possession of one party, and (2) the presumed fact is almost always true when the predicate fact that triggers the presumption is true, or (3) it is essential to break an evidentiary deadlock, even if the result is arbitrary. As discussed below, a rebuttable presumption that hydraulic fracturing caused groundwater contamination does not have any of these characteristics.

a. Relevant Evidence in a Hydraulic Fracturing Case Is Not Likely to Be Uniquely Within a Defendant's Possession

For example, evidence regarding the cause of any contamination is not uniquely within the defendant's possession. One of the important questions in contamination disputes will be "what was the quality of the plaintiff's water before drilling?"

Chemical analysis of the water often will be required to determine whether contamination is present. In states that require baseline testing, test results generally must be provided to the landowner.[116] Thus, the landowner should have access to the same baseline testing data that the operator possesses. If baseline testing is not required and is not performed, then the most likely scenario is that neither the plaintiff nor the defendant would have baseline water quality data. Assuming that the contamination is of a type that can be established by lay testimony, the landowner plaintiff, rather than the defendant, will be in the best position to give such testimony. Other relevant evidence might relate to potential causes of the contamination other than the defendant's operations. There is no reason to expect that the defendant will have any better access to that information than the plaintiff.

Of course, there will be some information to which the defendant has the best access, just as the plaintiff will have the best access to some evidence, but that is true in virtually every case, and is not in itself a justification for creating an evidentiary presumption.

116. *See, e.g.*, 58 PA. CONS. STAT. ANN. § 3218(e) (West Cum. Supp. 2013).

b. Evidence Suggests Hydraulic Fracturing Rarely Causes Contamination, and a Presumption that Fracturing Has Caused Contamination Generally Will Not Be Accurate

A second common characteristic of rebuttable presumptions is that the presumed fact will almost always be true if the predicate fact that triggers the presumption is true. The mailbox rule serves as an example. When a properly addressed and stamped envelope is deposited in the mail, the envelope almost always is delivered.

This raises a question regarding the rebuttable presumptions created in certain states—if contamination of groundwater happens to be noticed for the first time subsequent to hydraulic fracturing (this would be the predicate fact), does that mean that it almost always will be true that the hydraulic fracturing caused the contamination? The available evidence strongly suggests that the answer is "no" and that hydraulic fracturing rarely causes contamination of groundwater.

It often has been estimated that more than a million wells have been hydraulically fractured since the process was developed in the late 1940s and that, under current practices, about 90% of oil and gas wells drilled in the United States are hydraulically fractured.[117] If most hydraulic fracturing operations caused groundwater contamination, or even if a significant minority of such fracturing operations did so, there should be numerous documented cases of that happening, notwithstanding the fact that proving the cause of contamination sometimes is challenging. But there are few documented cases of groundwater contamination being caused by the process of hydraulic fracturing, and it is not clear that there is even a single case in which fractures created by hydraulic fracturing served as a pathway for groundwater contamination.

Several knowledgeable individuals have noted this. For example, Lisa Jackson, former Administrator of the Environmental Protection Agency ("EPA") under President Barack Obama, testified before Congress that she was unaware of any proven cases of

117. *See* INDEP. PETROLEUM ASS'N OF AMERICA, HYDRAULIC FRACTURING: EFFECTS ON ENERGY SUPPLY, THE ECONOMY, AND THE ENVIRONMENT (2008), *available at* http://energy indepth.org/docs/pdf/Hydraulic-Fracturing-3-E's.pdf.

groundwater contamination caused by hydraulic fracturing.[118] Gina McCarthy, the current Administrator of the EPA, also testified before a United States Senate Committee that she is unaware of any "definitive determinations" that hydraulic fracturing has ever caused groundwater contamination.[119]

Secretary of the Interior Ken Salazar has stated that hydraulic fracturing is safe,[120] and that he is unaware of any example of hydraulic fracturing causing contamination on public land.[121] Further, in testimony before a House Committee in 2011, Secretary Salazar stated that he was unaware of any persons being killed or seriously injured as a result of hydraulic fracturing,[122] and another official stated that the Department of the Interior is unaware of any problems created by the hydraulic fracturing that has been conducted in wells on federal lands.[123]

Several state regulatory agencies have made similar statements. For example, an Ohio Department of Natural Resources document states: "Since 1990, more than 15,000 Ohio wells have used hydraulic fracturing. During that time the Division of Oil and Gas Resources Management has conducted a number of water well investigation complaints—none of the investigations re-

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118. *See* Press Release, U.S. Senate Comm. on Env't & Pub. Works, EPA Administrator Lisa Jackson "Not Aware of Any Proven Case Where the Fracking Itself Has Affected Water" (May 24, 2011), *available at* http://www.epw.senate.gov/public/index.cfm?FuseAction=Minority.PressReleases&ContentRecord_id=23eb85dd-802a-23ad-43f9-da281b2cd287 ("I'm not aware of any proven case where the fracking process itself has affected water."). Video footage of Lisa Jackson's congressional testimony concerning groundwater contamination is available on YouTube. *See* EnergyInDepth, *EPA Administrator Lisa Jackson Tells Congress "No Proven Cases Where Fracking Has Affected Water,"* YOUTUBE (May 24, 2011), http://www.youtube.com/watch?v=L4RLzlcox5c (presenting video footage originally broadcast by Fox News).

119. *Senator David Vitter, Questions for the Record, Gina McCarthy Confirmation Hearing*, U.S. SENATE COMM. ON ENV'T & PUB. WORKS 67 (Apr. 8, 2013), http://www.epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=9a1465d3-1490-4788-95d0-7d178b3dc320.

120. Ashe Schow, *Ex-Cabinet Officials Ken Salazar, Steven Chu Praise Fracking as 'Safe'*, WASH. EXAMINER (Sept. 24, 2013, 11:30 AM), http://washingtonexaminer.com/ken-salazar-steven-chu-praise-fracking-as-safe/article/2536295.

121. Bob Beauprez, *America Is Poised to Be the World's New Energy Leader, Now Let's Vow to Claim This Crown*, FOXNEWS.COM (Jan. 17, 2012), http://www.foxnews.com/opinion/2012/01/17/america-is-poised-to-be-worlds-new-energy-leader-now-lets-vow-to-claim-this/.

122. *The Future of U.S. Oil and Natural Gas Development on Federal Lands and Waters: Hearing Before the H. Comm. on Natural Res.*, 112th Cong. 31 (2011) (statement of Ken Salazar, Secretary of Interior).

123. *Id.* at 49 (statement of Bob Abbey, Director, Bureau of Land Mgmt.).

vealed problems due to hydraulic fracturing."[124] A Michigan Department of Environmental Quality publication states that hydraulic fracturing "has been used on more than 12,000 wells in Michigan for more than fifty years without any consequence to the environment or public health."[125] A "frequently asked questions" page on the website of the Texas Railroad Commission, the agency that regulates oil and gas activity in Texas, states:

> Hydraulic fracturing has been an environmentally safe process for more than 60 years in Texas. The Railroad Commission has a comprehensive regulatory framework to ensure usable quality groundwater is protected. Commission records do not indicate a single documented water contamination case associated with the process of hydraulic fracturing in Texas.[126]

Further, a 2009 study prepared by the New York Department of Environmental Conservation included statements from regulators in fifteen states declaring that their state agencies had not documented any incidences of groundwater contamination caused by hydraulic fracturing,[127] and a United States Government Accountability Office report noted that investigations in several states had not found a link between groundwater contamination and shale drilling activity.[128]

Statements regarding the lack of documented cases of groundwater contamination caused by hydraulic fracturing have also come from persons who sometimes are critics of the oil and gas industry. Scott Anderson is a Senior Policy Advisor for the Environmental Defense Fund, an organization that has called for stricter regulation of the oil and gas industry.[129] He authored a

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124. Div. of Oil & Gas Res., *The Facts About Hydraulic Fracturing*, OHIO DEP'T OF NAT. RES., http://oilandgas.ohiodnr.gov/portals/oilgas/pdf/Facts-about-HFracturing.pdf (last visited Feb. 18, 2014) (emphasis omitted).

125. *Questions and Answers About Hydraulic Fracturing in Michigan*, MICH. DEP'T OF ENVTL. QUALITY, http://www.michigan.gov/documents/deq/deq-FINAL-frack-QA_384089_7.pdf (last visited Feb. 18, 2014).

126. *Hydraulic Fracturing Frequently Asked Questions*, R.R. COMM'N OF TEX., http://www.rrc.state.tx.us/about/faqs/hydraulicfracturing.php (last visited Feb. 18, 2014).

127. DIV. OF MINERAL RES., N.Y. STATE DEP'T OF ENVTL. CONSERVATION, SUPPLEMENTAL GENERIC ENVIRONMENTAL IMPACT STATEMENT ON THE OIL, GAS AND SOLUTION MINING REGULATORY PROGRAM (DRAFT) 5-144 to -145, app. 15 (2009), *available at* ftp://ftp.dec.state.ny.us/dmn/downtown/OGdSGEISFull.pdf.

128. U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-12-732, OIL AND GAS: INFORMATION ON SHALE RESOURCES, DEVELOPMENT, AND ENVIRONMENTAL AND PUBLIC HEALTH RISKS 49 (2012), *available at* http://www.gao.gov/assets/650/647791.pdf.

129. *Scott Anderson Bio*, ENVTL. DEF. FUND (Apr. 25, 2013), http://www.edf.org/people/scott-anderson.

blog post in which he listed multiple environmental issues raised by hydraulic fracturing and shale gas development generally.[130] He said it is not "impossible" for fracturing to cause contamination, but he also acknowledged that multiple studies of hydraulic fracturing have "not f[ou]nd any confirmed cases of drinking water contamination due to pathways created by hydraulic fracturing."[131]

In testimony before a United States House of Representatives Committee in 2012, Robert Howarth, a vocal critic of hydraulic fracturing, effectively conceded that there are no confirmed cases of hydraulic fracturing causing groundwater contamination, stating that there are "anecdotal" allegations.[132]

Marc Bern is a New York lawyer who is counsel for the plaintiffs in several of the pending cases in which landowners allege that their land or groundwater has been contaminated by hydraulic fracturing or other types of oil and gas activity. But in 2011, Mr. Bern co-authored an article in which he stated, "[i]f there is one piece of advice our firm has learned and can pass on, it is that plaintiff's counsel should stay away from the term 'fracking.'"[133] He goes on to explain, "[m]ost of the contamination documented to date arising from natural gas wells was caused by activities on the surface or by the construction of the gas well itself."[134]

Studies seem to confirm that hydraulic fracturing does not pose a significant threat to groundwater. For example, a United States Geological Survey study examined groundwater quality in 127 wells located in a portion of Arkansas that has seen significant drilling and hydraulic fracturing for the purposes of producing natural gas from the Fayetteville Shale.[135] The study compared

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130. Scott Anderson, *If the Problem Isn't Hydraulic Fracturing, Then What Is?*, ENVTL. DEF. FUND (Feb. 16, 2012), http://blogs.edf.org/energyexchange/2012/02/16/if-the-problem-isnt-hydraulic-fracturing-then-what-is/.

131. *Id.*

132. *Rhetoric v. Reality, Part II: Assessing the Impact of New Federal Red Tape on Hydraulic Fracturing & American Energy Independence: Hearing Before the Subcomm. on Tech., Info. Policy, Intergovernmental Relations & Procurement Reform of the H. Comm. on Oversight & Gov't Reform*, 112th Cong. 13 (May 31, 2012) (statement of Robert Howarth, Director, Agric., Energy & Env't Program, Cornell University), *available at* http://www.gpo.gov/fdsys/pkg/CHRG-112hhrg74754/html/CHRG-112hhrg747 54.htm.

133. Mark J. Bern & Tate J. Kunkle, *A Plaintiff's Primer on Litigating Natural Gas Cases*, WESTLAW J. ENVTL., June 8, 2011, at 3–4.

134. *Id.* at 4.

135. KRESSE ET AL., *supra* note 67, at 26–27.

groundwater samples collected less than two miles from shale gas activity to samples collected more than two miles from shale gas activity, and also compared the study's sample analyses to historical data.[136] The study found that "no regional effects on groundwater are apparent from activities related to gas production in the Fayetteville Shale in north-central Arkansas."[137]

In another study, Penn State University researchers collected water samples from 233 water wells in proximity to Marcellus Shale gas wells in Pennsylvania, including forty-eight "Phase I" sites at which the researchers collected samples both before and after drilling and fracturing.[138] The researchers "found no statistically significant increases in methane levels after drilling and no significant correlation to distance from drilling."[139] They analyzed pre-drilling and post-drilling samples for "potential pollutants that are most prominent in drilling waste fluids," and reported that "[r]esults . . . do not indicate any obvious influence from fracking in gas wells on nearby private water well quality."[140] At just one of the forty-eight sites, the researchers reported that there appeared to be "subtle increases" in constituents such as bromide, which the researchers stated was "not a direct health issue," but which they stated would justify more research.[141]

A group of Duke University researchers performed a study that has been cited by many critics of oil and gas development. The researchers based their study exclusively on post-fracturing samples from sixty-eight water wells in the Marcellus Shale regions of Pennsylvania and New York.[142] They found no evidence of contamination of the samples by fracturing fluids or the brines associated with deep formations to which oil and gas wells often are drilled.[143] They also stated that methane was found in a large percentage of water wells "regardless of [the proximity of] gas industry operations," but they concluded that a statistically significant correlation existed between a water well's proximity to the near-

136. *Id.*

137. *Id.* at 27.

138. BOYER ET AL., *supra* note 58, at 4.

139. *Id.*

140. *Id.* at 4, 21.

141. *Id.* Notably, the researchers found that pre-drilling samples from about 20% of the sites contained methane. *Id.* at 4.

142. Osborn et al., *supra* note 66, 8172–73.

143. *Id.* at 8172.

est natural gas well and the level of methane found in the water well.[144] The researchers stated that, assuming oil and gas activity caused the increased concentrations of methane, the most likely specific cause was well construction deficiencies, rather than the fractures created by the hydraulic fracturing.[145] Thus, although the researchers suspected that oil and gas activity might have contributed to higher methane concentrations in certain water wells, they concluded that hydraulic fracturing was not the most likely culprit.[146]

Another study was produced by a group of scientists and engineers who analyzed samples collected on behalf of Cabot Oil & Gas from more than 1700 water wells in Susquehanna County, Pennsylvania, an area that has seen significant Marcellus Shale activity.[147] The samples were collected prior to drilling by Cabot. The group's report stated that they found methane in 78% of the samples and did not find any correlation between methane concentrations in the water and the proximity of prior gas wells.[148] The authors also commented on the Duke study, stating that the data reported by the Duke scientists did not support a conclusion that oil and gas drilling had adversely affected water supplies.[149]

The EPA completed a study in 2004. The study consisted of a review of existing literature, and did not include sampling, but the report concluded that hydraulic fracturing "poses little or no threat" to underground sources of drinking water.[150]

Several recent claims of groundwater contamination allegedly caused by hydraulic fracturing have received significant publicity, but even these have not resulted in documented cases of groundwater contamination caused by hydraulic fracturing. One set of examples concerns allegations of groundwater contamination

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144. *Id.* at 8173.

145. *Id.* at 8175.

146. *Id.* Of course, the existence of a correlation, such as that found by the Duke researchers, does not indicate causation. That is, the correlation found by the researchers does not establish that the oil and gas activity caused the increased concentration of methane.

147. Molofsky et al., *supra* note 66, at 54.

148. *Id.* at 54–57.

149. *Id.* at 60–61

150. U.S. ENVTL. PROT. AGENCY, EPA 816-R-04-003, *Executive Summary* to EVALUATION OF IMPACTS TO UNDERGROUND SOURCES OF DRINKING WATER BY HYDRAULIC FRACTURING OF COALBED METHANE RESERVOIRS, at ES-1 (2004), *available at* http://www.epa.gov/ogwdw/uic/pdfs/cbmstudy_attach_uic_exec_summ.pdf.

around Dimock, Pennsylvania. After residents in the area complained about groundwater quality, the EPA collected and analyzed numerous water samples and for the most part found no groundwater contamination.[151] State officials concluded that oil and gas activity had adversely affected some water wells, but the state agency did not conclude that hydraulic fracturing had caused the problem.[152] Rather, they concluded that inadequate well construction was the cause.[153]

Industry critics have also have pointed to a study that was initiated after residents living near Pavillion, Wyoming complained about groundwater quality. The investigation included the collection and testing of water samples from several private water wells and also from two monitoring wells that were drilled deeper (and thus closer to the formation being fractured), than any of the private water wells. The EPA issued a draft report in which it concluded that domestic water wells near Pavillion, Wyoming likely were affected by hydraulic fracturing,[154] but the report was not peer reviewed, and both industry and Wyoming state officials challenged the report's conclusions.[155] The EPA announced plans to conduct a peer review, but subsequently announced that it was delaying any peer review and would not seek to rely on the report's conclusions.[156] Instead, the EPA stated that it would sup-

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151. Press Release, Envtl. Prot. Agency, EPA Completes Drinking Water Sampling in Dimock, Pa. (July 25, 2012), *available at* http://yosemite.epa.gov/opa/admpress.nsf/0/1A6E49D193E1007585257A46005B61AD.

152. *See* Press Release, Pa. Dep't Envtl. Prot., DEP Reaches Agreement with Cabot to Prevent Gas Migration, Restore Water Supplies in Dimock Township (Nov. 4, 2009), *available at* http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=2418&typeid=1.

153. *Id.*

154. DOMINIC C. DIGIULIO ET AL., U.S. ENVTL. PROT. AGENCY, INVESTIGATION OF GROUND WATER CONTAMINATION NEAR PAVILLION, WYOMING (DRAFT) xi–xiii (2011), *available at* http://www2.epa.gov/sites/production/files/documents/EPA_ReportOnPavillion_Dec-8-2011.pdf. In the EPA's press release issued when the draft report was released, the EPA stated that "ground water in the aquifer contains compounds likely associated with gas production practices, including hydraulic fracturing. EPA also re-tested . . . water wells in the community. The samples were consistent with chemicals identified in earlier EPA results . . . and are generally below established health and safety standards." Press Release, Envtl. Prot. Agency, EPA Releases Draft Findings of Pavillion, Wyoming Ground Water Investigation for Public Comment and Independent Scientific Review (Dec. 8, 2011), *available at* http://yosemite.epa.gov/opa/admpress.nsf/20ed1dfa1751192c8525735900400c30/ef35bd26a80d6ce3852579600065c94e!OpenDocument.

155. Abraham Lustgarten, *EPA's Abandoned Wyoming Fracking Study One Retreat of Many*, PROPUBLICA (July 3, 2013, 10:58 AM), http://www.propublica.org/article/epas-abandoned-wyoming-fracking-study-one-retreat-of-many.

156. Press Release, Envtl. Prot. Agency, Wyoming to Lead Further Investigation of

port the State of Wyoming's effort to conduct further studies of groundwater issues in the Pavillion area.[157] The State of Wyoming, which has stated that existing evidence does not justify a conclusion that hydraulic fracturing caused the groundwater contamination, has announced that it plans to complete its study by September 2014.[158]

Substantial attention also has been given to a movie that was highly critical of the oil and gas industry.[159] It contained scenes in which people gave anecdotal stories of adverse impacts allegedly caused by oil and gas activity. In one highly publicized scene, someone was able to turn on a water faucet in their home, hold a cigarette lighter to the discharge of the faucet, and light the discharge on fire, presumably because the water contained methane.[160] The movie discussed five sites in Colorado, three private water wells, and two locations where a creek had natural gas seeps.[161] The movie implied that the sites were each contaminated by hydraulic fracturing, but Colorado regulators investigated and found otherwise.[162] They found that the methane at three of the five sites was unrelated to oil and gas activity.[163] The regulators found that the methane at the other two sites was related to oil and gas activity, but that at least one of those was due to faulty construction of the oil and gas well, not hydraulic fracturing.[164]

There is one case in which state investigators concluded that hydraulic fracturing caused groundwater contamination. It occurred in West Virginia in the mid-1980s. State officials investigated a complaint about well water quality and concluded that

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Water Quality Concerns Outside of Pavillion with Support of EPA (June 20, 2013), *available at* http://yosemite.epa.gov/opa/admpress.nsf/0/DC7DCDB471DCFE1785257B90007377BF.

157. *Id.*; *see also* WYO. OIL & GAS CONSERVATION COMM'N, WELL BORE INTEGRITY—FINAL REPORT 1 (June 20, 2013), *available at* http://content.govdelivery.com/attachments/WYGOV/2013/06/20/file_attachments/220046/Additional%2BPavillion%2BAnalysis%2Bandnd%2BTesting.pdf.

158. *Id.* at 5.

159. Memorandum from the State of Colo. Oil & Gas Conservation Comm'n, Gasland Correction Document (Oct. 29, 2010), *available at* http://cogcc.state.co.us/library/GASLAND%20DOC.pdf; *see also* GASLAND (HBO Documentary Films 2010).

160. Mike Hale, *The Costs of Natural Gas Including Flaming Water*, N.Y. TIMES (June 20, 2010), http://www.nytimes.com/2010/06/21/arts/television/21gasland.html?_r=0.

161. Gasland Correction Document, *supra* note 159.

162. *Id.*

163. *Id.*

164. *Id.*

hydraulic fracturing fluid from a nearby fracturing job had caused the contamination.[165] The state regulators apparently concluded that a nearby, improperly abandoned old well provided a route for hydraulic fracturing fluid to enter the groundwater reservoir.[166] The regulators' analysis supports a conclusion that it is possible for hydraulic fracturing to cause groundwater contamination, but the evidence of numerous studies and decades of experience with hydraulic fracturing demonstrate that the West Virginia incident is the exception, not the rule. Thus, the existence of groundwater contamination subsequent to hydraulic fracturing does not mean that hydraulic fracturing is generally the cause of the contamination.

c. Hydraulic Fracturing Cases Are Not Cases in Which There Is a Need to Break an Evidentiary Deadlock, even if the Result Is Arbitrary

Finally, a third circumstance in which rebuttable presumptions are used is when an evidentiary deadlock—perhaps resulting from the absence of evidence—must be resolved, even if the resolution is arbitrary. An example is the old Louisiana rule of commorientes. This rule created a rebuttable presumption regarding who died first when two persons who were entitled to inherit from each other died in a common accident. The order of death could be critical because who ultimately inherited the property of both deceased individuals might depend on the order of death,[167] but there might not be evidence to resolve the order of death.[168]

The classic case applying the rule of commorientes was *Successions of Langles*. In that case, a mother and daughter went on a cruise.[169] The mother had previously executed a will making her

165. 1 U.S. ENVTL. PROT. AGENCY, EPA/530-SW-88-003, MANAGEMENT OF WASTES FROM THE EXPLORATION, DEVELOPMENT, AND PRODUCTION OF CRUDE OIL, NATURAL GAS, AND GEOTHERMAL ENERGY, at IV-22 (1987).

166. *Id.*

167. Suppose for example, a situation in which "Mother" executed a will stating, "I leave all of my property to Daughter if she survives me, and if Daughter does not survive me, I leave all of my property to X." "Daughter" executed a will stating, "I leave all of my property to Mother if she survives me, and if Mother does not survive me, I leave all of my property to Y." If Mother and Daughter both died in an accident, X would inherit the property of both Mother and Daughter if Daughter died first, but Y would inherit the property of both Mother and Daughter if Mother died first.

168. *See* Successions of Langles, 29 So. 739, 740 (La. 1900).

169. *Id.*

daughter her primary legatee, and making person "X" the legatee in the event that her daughter predeceased her.[170] The daughter had previously drafted a will that made her mother her primary legatee, and making person "Y" the legatee in the event that her mother predeceased her.[171] The cruise ship sank, and both mother and daughter drowned.[172] If the daughter died first, person "X" inherited the entire estate of the mother, and the mother's estate would include the daughter's entire estate as an asset. Thus, "X" would inherit both the mother's and the daughter's property. On the other hand, if the mother died first, "Y' would inherit everything. There was no evidence regarding who died first, but an evidentiary deadlock was not tolerable because the property had to be awarded to someone.[173] The law of commorientes avoided a deadlock by creating an arbitrary presumption that the older individual died first.[174]

But if a plaintiff brings a contamination claim, there is no need to create a presumption in order to break an evidentiary deadlock. The law is already structured to avoid a deadlock by providing that the plaintiff (in most civil cases) has the burden of proving each element of his or her claim by a preponderance of the evidence. There is no basis for an evidentiary deadlock. If the plaintiff cannot meet the burden of proof, his claim fails.

d. Should Evidentiary Presumptions Be Used?

A rebuttable presumption that hydraulic fracturing was the cause of groundwater contamination does not share certain characteristics commonly found in the rebuttable presumptions recognized by law. For example, the mere fact that groundwater contamination is found subsequent to hydraulic fracturing taking place in an area is *not* sufficient to show that hydraulic fracturing almost certainly was the cause. Further, the evidence regarding the potential causes of contamination is not likely to be exclusively in the control of a company that conducted a fracturing operation. And hydraulic fracturing contamination cases are not a type

170. *Id.* at 739–40.
171. *Id.* at 740.
172. *Id.*
173. *Id.* at 740–41.
174. *Id.* at 753.

of case in which it is essential to break an evidentiary deadlock, even if the result is arbitrary.

Because the circumstances that would justify use of an evidentiary presumption are not present, states should follow the rule that generally applies in litigation—namely, that a plaintiff must prove all required elements of his claim, even in a complex case. It is bad public policy to deviate from this rule with respect to defendants from a particular industry, essentially by requiring them to disprove certain claims asserted against them. This is particularly true when the rebuttable presumption that would reverse the normal burden of proof—an evidentiary presumption that hydraulic fracturing caused contamination—does not share characteristics typically found in the rebuttable evidentiary presumptions already recognized by the law.

Imposing rebuttable presumptions might assist some plaintiffs in contamination litigation, but there is no sound public policy reason to do so across the board without considering actual responsibility for having caused or contributed to the contamination. Rather, the appropriate policy should be to determine who caused the contamination and impose liability against that party. The surest way to determine what caused the contamination is to require baseline testing, not to shift burdens of proof.

An argument in support of creating a rebuttable presumption is that it would provide an incentive for an operator to conduct baseline testing. But given the strong reasons not to create such a presumption, the better argument is that states should not create evidentiary presumptions that hydraulic fracturing operations caused groundwater contamination. Instead, the states should simply require testing.

If a state is determined to provide an extra incentive for companies to perform baseline testing and it wishes to use a rebuttable presumption to do that, the state could require companies to conduct baseline testing and also implement a rebuttable presumption that applied only in the event that the company failed to perform required baseline testing. That policy would avoid the general imposition of a rebuttable presumption that is not justified based on the typical circumstances that warrant creating such presumptions, and the policy still would give companies an additional incentive to conduct the testing required by law.

4. States Should Not Use Irrebuttable Presumptions that Hydraulic Fracturing Caused Contamination

Both Pennsylvania and West Virginia have enacted rebuttable evidentiary presumptions that encourage baseline testing.[175] In addition, their statutes appear to create irrebuttable presumptions that hydraulic fracturing operations are the cause of contamination if contamination is found within a certain area, within a certain time frame, and the operator of the oil and gas well did not perform baseline testing.[176]

These rules are rather extraordinary. They go well beyond strict liability because strict liability simply allows for liability in the absence of negligence—strict liability does not impose liability on a defendant whose activities did not cause harm. Further, such rules go well beyond a mere evidentiary presumption because an evidentiary presumption can be rebutted—an evidentiary presumption would not impose liability on a defendant who could affirmatively prove that its activities did not cause the plaintiff's harm.

Effectively, the rules punish an operator who fails to perform baseline testing by providing that in certain circumstances, the operator will become an insurer against any harm caused by groundwater contamination no matter what the cause of the contamination—natural or human. This is an extraordinary result. Pennsylvania and West Virginia law do not require an operator to perform baseline testing. Yet their laws would use an irrebuttable presumption to punish an operator for failing to perform *voluntary* testing. Moreover, the liability for groundwater contamination can be enormous.[177]

It is far from clear that this is sound public policy. Is it reasonable to punish an operator for failing to perform a task that the law does not require the operator to perform? Moreover, even if one argues that, through such a penalty, these states effectively make it illegal not to perform baseline testing, there are still major flaws in any such irrebuttable presumption scheme. For ex-

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175. 58 PA. CONS. STAT. ANN. § 3218 (West Cum. Supp. 2013); W. VA. CODE ANN. § 22-6A-18 (LexisNexis Supp. 2013).

176. 58 PA. CONS. STAT. ANN. § 3218; W. VA. CODE ANN. § 22-6A-18.

177. 58 PA. CONS. STAT. ANN. §§ 3255–3256 (West Cum. Supp. 2013); W. VA. CODE ANN. § 22-6A-19 (LexisNexis Supp. 2013).

ample, the Supreme Court of the United States has held that the level of punishment should be somewhat predictable and not completely arbitrary.[178] But the rebuttable presumption scheme makes the level of punishment highly arbitrary.

If, for example, an operator fails to perform baseline testing and contamination is later discovered within the area and time frame specified in the state statute, then the statute punishes the operator. The statute punishes an operator by imposing an irrebuttable presumption that it is liable, even if the operator can clearly prove that it did not cause the contamination. And, because the costs of remediating contamination can be huge, the liability penalty could be substantial.

In contrast, if an operator fails to perform baseline testing, but no contamination is discovered during the requisite area and time frame, the operator will not incur any liability penalty, even though it is no less "guilty" of failing to perform baseline testing than the other operator.

Moreover, penalties should not be substantially disproportionate to the severity of the "improper" conduct.[179] Damages for groundwater contamination can be enormous.[180] If liability for such contamination is imposed on an operator who can affirmatively prove that it did not cause the contamination, the imposition of liability cannot reasonably be regarded as anything other than a penalty. The typical civil penalties for regulatory violations that do not result in harm are far below a potential damages award for groundwater contamination.[181]

Indeed, imposing such civil liability on a defendant who did not cause the harm arguably raises due process questions. In private civil litigation, a defendant typically does not have any liability for damages his conduct did not cause. Thus, imposing compensatory liability on a defendant that did not cause the harm, and do-

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178. Exxon Shipping Co. v. Baker, 554 U.S. 471, 506 (2008).

179. The text puts "improper" in quotation marks because one could argue that it is not improper for an operator to refrain from performing baseline testing when the law does not require it to be done.

180. *See, e.g.*, 58 PA. CONS. STAT. ANN. §§ 3255–3256; W. VA. CODE ANN. § 22-6A-19; Don Jeffery & Sarah Earle, *Exxon Mobil Is Found Negligent in New Hampshire MTBE Use*, BLOOMBERG (Apr. 10, 2013), http://www.bloomberg.com/news/2013-04-09/exxon-mobile-is-found-negligent-in-new-hampshire-mtbe-use.html.

181. *Compare* 58 PA. CONS. STAT. ANN. §§ 3255–3256, *and* W. VA. CODE ANN. § 22-6A-19, *with* Jeffery & Earle, *supra* note 180.

ing so for purposes of punishing the defendant, could be analogized to punitive damages. The Supreme Court has held that punitive damages awards cannot be out of proportion to the severity of the offense.[182] Further, the Supreme Court has held that punitive damages awards generally should not be out of proportion to the harm caused by the *defendant's* actions.[183] If the defendant's actions did not cause a plaintiff's harm, then a large damages award imposed on the defendant easily could be interpreted as being out of proportion to the harm caused by the defendant's conduct.

Moreover, punitive damages awards have significant similarity to criminal penalties, and in the criminal context, courts have held that irrebuttable presumptions can violate a defendant's constitutional rights.[184] In other contexts involving important rights, the Supreme Court has similarly held that irrebuttable presumptions can violate a person's rights.[185]

Further, the Supreme Court has stated that the amount of punitive damages awards should be reasonably predictable,[186] and that one way of making such damages awards predictable is to tie them to a maximum ratio of the actual damages caused by a defendant's conduct.[187] Given that damages awards in contamination cases can vary widely and be very large, punishing a defendant by imposing an irrebuttable presumption that it caused certain contamination could lead to unpredictable punishments.

The Supreme Court has also held that punitive damages awards must not be disproportional to the reprehensibility of a defendant's conduct, and that one basis for determining whether punitive damages are excessive is to compare the damages to the civil or criminal penalties that could be imposed for similar conduct.[188] The damages for remediation of contamination can be

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182. *Baker*, 554 U.S. at 502.

183. *Id.* at 493.

184. *See id.* at 504–05; U.S. Dep't of Agric. v. Murray, 413 U.S. 508, 516 (1973) (Stewart, J., concurring); Vlandis v. Kline, 412 U.S. 441, 446 (1973). Moreover, the severity of a penalty should be reasonably predictable. *Baker*, 554 U.S. at 502. The potential range of damages awards that can arise from groundwater contamination vary enormously.

185. *Murray*, 413 U.S. at 516 (Stewart, J., concurring); *Vlandis*, 412 U.S. at 446.

186. *Baker*, 554 U.S. at 502.

187. *Id.* at 506.

188. BMW of North America, Inc. v. Gore, 517 U.S. 559, 575, 583 (1996).

substantial—sometimes tens to hundreds of millions of dollars.[189] If a company is held liable for contamination that it demonstrably did not cause, such liability could be much larger than the typical civil or criminal penalty imposed for breach of a state regulatory requirement where the breach did not cause harm.

On the other hand, the Supreme Court has stated that the excessiveness of a punitive damages award can be judged based on the actual or *potential* harm from the defendant's conduct.[190] Assume a potential harm could arise from a defendant not performing baseline testing. *If* the defendant caused contamination, the defendant's failure to conduct baseline testing *might* make the difference in whether a plaintiff could prove a contamination claim. In this scenario, the irrebuttable imposition of liability might not run afoul of constitutional limits on civil punishment schemes. But even if one accepts that such an argument is persuasive and that the irrebuttable presumption penalty does not rise to the level of a constitutional violation, the penalty still seems grossly unfair in the event that evidence clearly shows that the defendant did not cause the contamination at issue.

Moreover, a plaintiff's ability to impose such liability on a defendant that did not cause the contamination would reduce a plaintiff's incentive to determine which person actually caused the contamination. Thus, a person who actually caused the contamination might escape liability. Or, if the contamination resulted from natural causes, the plaintiff could get a windfall—compensation from the defendant for naturally occurring contamination. Together, these considerations suggest that states should not use irrebuttable presumptions that fracturing caused contamination.[191]

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189. State v. Allstate Ins. Co., 201 P.3d 1147, 1152 (Cal. 2009); Corbello v. Iowa Prod., 850 So. 2d 686, 691–92 (La. 2003).

190. State Farm Mut. Auto. Ins. Co. v. Campbell, 538 U.S. 408, 418 (2013).

191. Another potential problem is that Pennsylvania does not keep a registry of private water wells. *Private Water Wells*, PA. BUREAU OF SAFE DRINKING WATER, http://www.depweb.state.pa.us/portal/server.pt/community/private_water_wells/20690 (last visited Feb. 18, 2014). Thus, an oil or gas company does not necessarily know where every private water well is located.

III. ISSUES TO DECIDE IN STRUCTURING A BASELINE TESTING REGIME

If a state implements a mandatory baseline testing program, it will face numerous issues regarding the specifics of the program, including the eleven issues discussed below.

A. *How Far from a Well Should Testing Be Required?*

If a state is going to require companies to perform baseline testing of water sources located within some distance of its oil and gas wells, the state must decide what that distance will be. Further, the state must decide whether that distance will be measured from the surface location of the oil and gas well (the wellhead), or from all points along the entire length of a horizontal well's lateral, or from the most distant points to which the company projects fractures will propagate.[192]

There are sound reasons why a state might require testing only for some specified radius around the wellhead. Although some members of the public worry that hydraulic fracturing will cause groundwater contamination, evidence suggests that such contamination would be very rare. Many people knowledgeable about hydraulic fracturing and oil and gas operations—including both industrialists and environmentalists—believe that hydraulic fracturing itself is unlikely to cause groundwater contamination.[193] If contamination occurs, it is much more likely to result from a surface spill, blowout, or a casing and cementing failure in the vertical section of the well, and for each of these potential causes of contamination, the area around the wellhead is most critical. The entire length of a lateral is not.[194]

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192. If a state were going to base the area where pre-fracture testing is required on fracture lengths, the state would need to use *projected* fracture lengths because it is impossible for companies to precisely control the length of fractures.

193. *See, e.g.*, Steve Everley, *How Anti-Fracking Activists Deny Science: Water Contamination*, ENERGYINDEPTH (Aug. 13, 2013, 9:09 AM), http://energyindepth.org/national/how-antifracking-activists-deny-science-contamination/ (setting forth statements from various scientific studies indicating that there is a lack of evidence showing that fracking contributes to water contamination).

194. The most likely location of a surface spill is the location where surface operations are being conducted. Such operations will take place at the wellhead, and probably at some other locations, but not along the entire distance of a horizontal lateral. Similarly, a blowout will result in a release of hydrocarbons around the wellhead. If a casing or ce-

Consistent with these facts, some states and organizations require or encourage testing of water sources within a specified distance of the wellbore, rather than testing all water sources within a specified distance from any portion of a lateral or projected fracture length. For example, CAPP recommends testing of domestic water wells located "within 250 meters of the wellhead, or as required by regulation."[195] The Center for Sustainable Shale Development calls for testing of waters within a "2,500 foot radius of the wellhead (or greater distance, if a need is clearly indicated by geologic characterization)."[196]

Illinois requires testing of "all water sources" within 1500 feet of the "well site,"[197] with "well site" being defined as the "surface areas" where equipment or facilities are located and operations take place.[198] Ohio requires testing be performed for water wells located within 1500 feet of the proposed wellhead location for a new horizontal well.[199] If a proposed new well is a vertical well that would be drilled in an urbanized area, baseline testing must be performed for water wells located within 300 feet of the proposed drilling site.[200]

Wyoming's regulations require testing of water sources within a distance of one-quarter mile from the surface location of the well.[201] Colorado requires sampling and monitoring from "all Available Water Sources, up to a maximum of four (4), within a one-half (1/2) mile radius of a proposed Oil and Gas Well."[202]

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menting failure is going to cause contamination, the mechanism for that event will involve hydrocarbons or other fluids traveling from a formation at a deeper depth to a formation at a shallower depth by moving upward along the outer edge of the wellbore, between the earth and the wellbore. That would occur in the vertical section of the wellbore, which generally will be beneath the wellhead.

195. CANADIAN ASS'N OF PETROLEUM PRODUCERS, *supra* note 77, at 3.

196. CTR. FOR SUSTAINABLE SHALE DEV., *supra* note 81, at 3.

197. 225 ILL. COMP. STAT. ANN. 732/1-80(b) (Westlaw through P.A. 98-623 of the 2013 Reg. Sess.).

198. 225 ILL. COMP. STAT. ANN. 732/1-5 (Westlaw through P.A. 98-623 of the 2013 Reg. Sess.).

199. OHIO REV. CODE ANN. § 1509.06(A)(8)(c) (LexisNexis Repl. Vol. 2013).

200. *Id.* § 1509.06(A)(8)(b). If regulators determine that conditions at a particular site warrant a revision of the testing requirements for horizontal wells or vertical wells in an urbanized area, the regulators may revise the distance within which testing must be done. *Id.*

201. WYO. CODE R. (Oil & Gas Conservation Comm'n), ch. 3 § 46(b)–(c) (2014). Wyoming enacted baseline testing regulations in November 2013, and those regulations became effective in March 2014.

202. COLO. CODE REGS. § 404-1:609(b) (2014).

Thus, most of the states that have addressed the issue so far have opted to require testing within a specified distance of the *wellhead*, rather than within some distance from the entire lateral or projected fracture lengths. This appears to be the soundest approach. The available evidence concerning risk does not seem to justify requiring operators to test all water sources within a specified distance of either the entire length of the lateral or the entire length of fractures, and such approaches could significantly increase the cost of testing by increasing the number of water sources that must be tested.

Nevertheless, some arguments can be made for requiring testing within a specified distance of any portion of the laterals or projected fracture lengths. Although most formations that are fractured are located so far below the depths of underground sources of drinking water that it would be almost impossible for a fracture created by hydraulic fracturing to span that distance or even for the hydraulic fracture to combine with any pre-existing natural fracture to span that distance, hydraulic fracturing occasionally is conducted in shallower formations. In such cases, the possibility that fractures would serve as a pathway for contamination becomes more plausible, even if still unlikely.

Also, perhaps in highly unusual situations, natural fractures or permeable connections between formations might be sufficient to provide a pathway for contamination. Further, if old, improperly abandoned wells were drilled as deep or deeper than the nearby formation being fractured, the old wellbores could potentially become a pathway for contamination somewhere beyond the wellhead of the well being hydraulically fractured.

Finally, although it seems clear that the public's fear that fracturing will harm groundwater is not justified by available evidence, it is also clear that a significant minority of the population fears the process. Some officials or regulators could conclude that baseline testing would address public concern, and that this justifies requiring testing within a specified distance of the entire wellbore.

Although most states that require baseline testing only require testing within the radius around the wellhead, California requires that testing be conducted at a specified distance from the entire lateral. California Public Resources Code sections 3160(d)(6)(A) and (7)(A) grant landowners and surface tenants within

1500 feet of the wellhead, as well as those within 500 feet from the surface projection of the lateral, to request testing of any water well that produces water suitable for drinking and any source of surface water that is suitable for drinking or irrigation.[203]

No state has opted to require testing of all water sources within a specified distance of the projected length of fractures. But one industry organization's best practices guide suggests that approach. An API guidance document recommends that, "[t]he area of sampling should be based on the anticipated fracture length plus a safety factor."[204]

B. *Should There Be a Limit on the Number of Water Sources that Must Be Tested?*

Another question is whether there should be a limit on the number of water sources that must be tested. Such a limit could help prevent the testing program from becoming too costly.[205] And, if the water sources that were tested were located in different directions from the oil or gas well being hydraulically fractured, the testing might be effective to show whether the oil and gas activities were causing groundwater contamination, even though testing was not performed on all water sources in the area. The disadvantage of placing a limit on the number of wells that must be tested is that the limit would make the testing program less comprehensive.

Colorado places a limit on the number of water sources that must be tested. The state's baseline testing regulation requires companies to perform baseline testing of water wells within a specified distance of the company's oil or gas well, up to a maximum of four water wells.[206] To ensure that the water wells tested provide the most comprehensive information possible, the regulation generally requires that the water wells chosen for sampling be selected in a radial pattern around the oil or gas well, and that if the direction of subsurface water flow is known, that wells in

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203. CAL. PUB. RES. CODE §§ 3160(d)(6)(A)–(7)(A) (West Cum. Supp. 2014).

204. AM. PETROLEUM INST., *supra* note 76, at 20.

205. This article concluded that baseline testing would not be cost prohibitive, though it could become cost prohibitive if an excessive number of samples must be collected and analyzed. *See supra* Part II.A.

206. COLO. CODE REGS. § 404-1:609(b).

both the up gradient and down gradient directions be chosen for sampling.[207]

Wyoming does not place a cap on the number of water wells that must be tested, but the state's testing regulation requires testing of all water sources, up to four, located within a specified distance of the oil and gas well, and states that if there are more than four water sources within that distance from the oil and gas well, the operator of the well must submit a proposed testing plan to the Wyoming Oil and Gas Conservation Commission.[208] This could provide relief from the necessity to test all sources of water within the specified distance.

In contrast, other states that have enacted testing regulations do not place a limit on the number of water wells that must be tested.

C. *Will the Testing Requirement Apply to Both Groundwater and Surface Water?*

Another issue is whether testing should include only groundwater or whether it should also include surface waters. There are reasons why a state might choose to include only groundwater, in testing. A significant portion of this country's drinking water comes from underground sources. Oil and gas activities include significant subsurface operations, and it is possible for those operations to cause contamination. When that happens, it is not impossible for contamination to migrate to surface waters, but it is groundwater and the subsurface that are most directly affected.

Of course, oil and gas activities on the surface can also cause contamination of surface waters through spills or other incidents,[209] but that is also true of the activities of hundreds of other industries that involve handling potentially hazardous substances, and companies in those industries are not usually required to perform baseline testing of surface water. Further, in contrast to subsurface events that cannot be seen, incidents on the surface

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207. *Id.*

208. WYO. CODE R. (Oil & Gas Conservation Comm'n), ch. 3 § 64(a)–(c) (2014).

209. Of course, such contamination could migrate to underground sources of drinking water.

are less likely to go unobserved than are incidents below the surface.

Whether for these reasons or otherwise, several states' mandatory testing programs, as well as some associations' best practices guides, apply only to groundwater. For example, CAPP's best practices guide only addresses groundwater.[210] Colorado's baseline testing rule appears to apply only to groundwater.[211] Ohio's statute addresses testing of wells that supply groundwater.[212]

Wyoming's regulations require testing of "water sources," which is defined to include water wells and springs that have received permits for beneficial water use, and monitoring wells that have been permitted by certain state agencies.[213] Thus, Wyoming also only requires testing of groundwater sources.

On the other hand, the API's best practices guide, HF1, recommends testing both groundwater and surface water sources,[214] and the Center for Sustainable Shale Development calls for testing both groundwater and surface water.[215] California Public Resources Code section 3160(d)(7)(a) grants landowners and surface tenants, whose property is within specified distances from an oil and gas well, the right to request testing of drinking water wells and any source of *surface water* that is suitable for drinking or irrigation.[216] Illinois law does not require testing of all surface waters, though it does require testing of some. Specifically, Illinois requires sampling and testing of all "water sources" within 1500

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210. CANADIAN ASS'N OF PETROLEUM PRODUCERS, *supra* note 77, at 1.

211. The rule requires sampling and monitoring from "all Available Water Sources, up to a maximum of four (4), within a one-half (1/2) mile radius of a proposed Oil and Gas Well." COLO. CODE REGS. § 404-1:609(b). The rule does not define "Available Water Sources," but the rule is entitled "Statewide Groundwater Baseline Sampling and Monitoring," and the regulation makes several references to "groundwater." *Id.* § 404-1:609. Further, the regulation states that "[w]ell maintained domestic water wells are preferred over other Available Water Sources" as sample locations. *Id.* § 404-1:609(b)(2).

212. OHIO REV. CODE § 1509.06(A)(8)(a)–(b) (LexisNexis Repl. Vol. 2013).

213. *See* WYO. CODE R. (Oil & Gas Conservation Comm'n), ch. 1 § 2(e) (2014) (defining "Available Water Source"); *id.* ch. 1, § 2(iii) (defining "Water Source"); *id.* ch. 3 § 46 (requiring testing of "available water sources").

214. AM. PETROLEUM INST., *supra* note 76, at 20.

215. CTR. FOR SUSTAINABLE SHALE DEV., *supra* note 81, at 3.

216. CAL. PUB. RES. CODE § 3160(d)(7)(A) (West Cum. Supp. 2014). California Public Resources Code section 3160(d)(6)(B) requires that the operator of the oil or gas well hire an independent entity to identify the landowners and tenants within that area and to provide them with a copy of the operator's permit to conduct hydraulic fracturing and with information on available sampling and testing. *Id.* § 3160(d)(6)(B).

feet of a well site.[217] The Illinois statute defines "water source" to mean "(1) any existing water well or developed spring used for human or domestic animal consumption, or (2) any river, perennial stream, aquifer, natural or artificial lake, pond, wetland listed on the Register of Land and Water Reserves, or reservoir."[218]

D. *Should Post-Fracturing Sampling and Testing Be Required?*

Another question to answer when a state begins requiring *pre*-fracturing testing is whether *post*-fracturing testing will also be required. The argument for requiring *post*-fracturing testing is somewhat weaker than the argument for always requiring *pre*-fracturing testing. This is because one of the benefits of groundwater testing is that it helps resolve allegations that fracturing at a specific site caused contamination. In most cases, oil and gas activity does not cause groundwater contamination and there is never an allegation that the particular activity has caused contamination. Thus, baseline testing will not be needed to resolve a dispute at most sites. But *pre*-fracturing testing cannot wait until a post-fracturing contamination dispute arises. Either testing is done before fracturing, when it is not known whether a future dispute will arise, or the opportunity to do pre-fracturing testing is lost.

In contrast, the opportunity to perform post-fracturing testing is not lost if the company waits until an allegation of groundwater contamination arises. Thus, it would not be unreasonable for a state to require pre-fracturing testing but not to require post-fracturing testing. On the other hand, post-fracturing testing can provide benefits other than helping to resolve a contamination allegation. For example, if the fracturing operation has caused groundwater contamination that is not apparent to the landowner, post-fracturing testing could reveal that hazard. This is not an especially compelling basis for requiring post-fracturing testing because the risk that any particular oil and gas operation will cause groundwater contamination is low, and sometimes contamination would be evident, rather than non-apparent. Neverthe-

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217. 225 ILL. COMP. STAT. ANN. 732/1-80(b) (Westlaw through P.A. 98-626 of the 2013 Reg. Sess.).

218. 225 ILL. COMP. STAT. ANN. 732/1-5 (Westlaw through P.A. 98-626 of the 2013 Reg. Sess.).

less, this is a potential benefit. Further, the data supplied by post-fracturing testing could also be beneficial for purposes of increasing the publicly available knowledge regarding the likelihood that oil and gas activities will affect groundwater.

States have taken different approaches to this issue. For example, Pennsylvania and West Virginia create an incentive to conduct pre-fracturing testing by the use of certain presumptions, but those states' regulations do not create the same incentive to conduct post-fracturing testing.[219] Ohio requires pre-fracturing testing, but does not require post-fracturing testing.[220]

The API's HF1 best practices guide recommends that companies perform pre-fracturing baseline testing, but does not discuss post-fracturing testing.[221] The CAPP best practices also refer to testing water "before" drilling.[222] And in the public comment period for Wyoming's baseline testing regulation, some of the companies that supported pre-drilling testing opposed post-drilling testing.[223]

Other states or organizations, however, do require or support post-drilling testing. For example, the Center for Sustainable Shale Development calls for testing to be performed for "periodic monitoring for at least one year following completion of the well."[224] Colorado's regulations require sampling "prior to setting conductor pipe"[225] (the conductor pipe is set early in the well drilling process) and also require two rounds of sampling and analyses *after* drilling—one set between six and twelve months after completion of the well and a second round between sixty and seventy-two months after completion[226]—though wells that are aban-

219. 58 PA. CONS. STAT. ANN. § 3218(c) (West Cum. Supp. 2013); W. VA. CODE ANN. § 22-6A-18 (LexisNexis Supp. 2013).

220. OHIO REV. CODE ANN. § 1509.06 (LexisNexis Repl. Vol. 2013).

221. AM. PETROLEUM INST., *supra* note 76, at 20.

222. CANADIAN ASS'N OF PETROLEUM PRODUCERS, *supra* note 77. CAPP's best practices do suggest, however, the establishment of regional monitoring plans, rather than just pre-drilling samples. *Id.*

223. *See, e.g.*, Greg Fladager, *O&G Commission Talks Pre-Drill Water Testing—Intends to Build Statewide Baseline Water Database*, CASPER J. (Aug. 5, 2013, 3:00 PM), http://www.casperjournal.com/business/article_0d75ff46-88d3-5c5d-9b5e-cc872d233f36.html.

224. CTR. FOR SUSTAINABLE SHALE DEV., *supra* note 81, at 3.

225. COLO. CODE REGS. § 404-1:609(d)(1) (2014).

226. *Id.* § 404-1:6(9)(d)(2).

doned without ever having produced hydrocarbons are exempt from the post-drilling sampling requirements.[227]

California's statute requires post-stimulation testing "on the same schedule as the pressure testing of the well casing of the treated well."[228] California has also enacted legislation requiring regulators to develop a plan for monitoring the effect of well stimulation on groundwater no later than January 1, 2015.[229] Illinois requires testing six months, eighteen months, and thirty months after the hydraulic fracturing operation is completed.[230]

Wyoming's regulations require that an "initial sampling and testing" be done prior to the start of drilling, and that two rounds of post-drilling sampling and testing be performed. The first round of post-drilling sampling and testing must be done between twelve and twenty-four months after the operator of an oil or gas well sets the production casing or liner in the well,[231] and the second round must be performed at least twenty-four months after the first round of post-drilling sampling and testing, but no later than forty-eight months after the operator sets the production casing or liner.[232]

E. *Should Testing Be Required Prior to Any Oil and Gas Drilling, or Only Prior to Drilling Wells that Will Be Hydraulically Fractured?*

States that enact mandatory testing requirements also must decide whether testing is required when any oil and gas well will be drilled, or only when a well will be hydraulically fractured. There are a few reasons why a state might choose to limit mandatory baseline testing to circumstances in which an oil and gas well will be hydraulically fractured. For example, much of the increased public concern about oil and gas activity has focused on hydraulic fracturing. Further, because the cost of drilling and completing a well that is hydraulically fractured tends to be much higher than the cost to drill and complete an otherwise compara-

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227. *Id.*

228. CAL. PUB. RES. CODE § 3160(d)(7)(A)(ii) (West Cum. Supp. 2014).

229. CAL. WATER CODE § 10783 (West Cum. Supp. 2014).

230. 225 ILL. COMP. STAT. 732/1-80(c) (Westlaw through P.A. 98-626 of the 2013 Reg. Sess.).

231. WYO. CODE R. (Oil & Gas Conservation Comm'n), ch. 3 § 46(e) (2014).

232. *Id.*

ble well that is not hydraulically fractured, the costs of baseline testing probably will be a smaller portion of the costs of a hydraulically fractured well. Therefore, baseline testing is less likely to be cost prohibitive for a well that is not hydraulically fractured.

On the other hand, assuming that a reasonable limit is placed on the number of samples that must be collected and analyzed, the cost of testing often will be a small portion of overall costs even if a well is not hydraulically fractured.[233] Further, although some members of the public have become particularly concerned about hydraulic fracturing, many observers believe that any groundwater contamination caused by oil and gas activity is less likely to arise from hydraulic fracturing than from such things as a well construction problem, a surface spill, or a blowout—any of which can occur whether or not a well is hydraulically fractured. Thus, if actual risk is considered instead of the public's perceived risk, requiring baseline testing before the drilling of every oil and gas well is just as reasonable as requiring testing before the drilling of a well that will be hydraulically fractured.

States have taken a variety of approaches on this issue. Illinois requires testing before "high volume horizontal hydraulic fracturing."[234] Alaska's proposed baseline testing rule would only require testing prior to fracturing.[235]

In contrast, Colorado requires baseline testing before drilling any well,[236] as does Wyoming's new baseline testing regulation.[237] Ohio requires testing prior to drilling horizontal wells and any oil and gas wells in urban areas.[238]

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233. *Compare, e.g.*, CMTY. SCI. INST., BASELINE WATER QUALITY TESTING WITH RESPECT TO GAS WELLS, http://www.communityscience.org/wp-content/uploads/2012/06/Baseline-Testing-explanation-and-fees-073013.pdf (last visited Feb. 18, 2014) (outlining the costs of baseline water testing), *with* William E. Hefley et al., *The Economic Impact of the Value Chain of a Marcellus Shale Well* 83 tbl.A-1 (Pitt. Bus. Working Papers, Aug. 30, 2011) (breaking down the total costs of gas well drilling).

234. 225 ILL. COMP. STAT. ANN. 732/1-80(b).

235. Notice of Proposed Changes in the Regulations of the Alaska Oil & Gas Conservation Commission, Alaska Oil & Gas Conservation Comm'n *1 (to be codified as ALASKA ADMIN. CODE tit. 20, § 25.283(a)(4)) (proposed Dec. 20, 2012).

236. COLO. CODE REGS. 404-1:609(d)(1) (2014).

237. WYO. CODE R. (Oil & Gas Conservation Comm'n), ch. 3 § 46.

238. OHIO REV. CODE ANN. § 1509.06(A)(8) (LexisNexis Repl. Vol. 2013).

F. *What Substances Should Companies Test For?*

Another question concerns the potential contaminants for which testing should be performed. A detailed technical discussion of this topic is beyond the scope of this article, but the regulations and legislation of several states provide lists of the analytes for which those states require testing.[239]

One issue that was raised during the public comment period for Wyoming's baseline testing regulation was whether oil and gas companies should be required to test for potential water contaminants that are not generally related to oil and gas activity.[240] An industry organization objected to the proposed regulation's requirement that companies test for nitrates and nitrites (a requirement that remained in the version of the regulation that was enacted).[241] The organization asserted that those potential contaminants are associated with agricultural activities, but not with oil and gas activities, and that it is not reasonable to require oil and gas companies to test for those substances.[242]

Although testing for a broad range of substances might be useful for some purposes, it is reasonable to argue that the considerations that justify requiring oil and gas companies to conduct and pay for testing do not apply with respect to potential contaminants that are unrelated to oil and gas activity. On the other hand, if a company is going to collect samples and conduct analyses, testing for certain additional analytes might not significantly add to the costs of sample collection and testing, and such testing might be worthwhile to perform, even from an oil and gas

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239. *See, e.g.*, COLO. CODE REGS. § 404-1:609(e); 225 ILL. COMP. STAT. ANN. 732/1-80(e); WYO. CODE R. (Oil & Gas Conservation Commission), ch. 3 § 46(h). The California statute does not specify the analytes for which testing must be performed, but the new legislation requires regulators to develop a plan, prior to January 1, 2015, for groundwater monitoring to evaluate the effect of well stimulation activities, and that plan must include guidelines regarding required analytes. CAL. WATER CODE § 10783(h)(1), (k)(2) (West Cum. Supp. 2014).

240. Greg Fladager, *State Adopts Baseline Water Testing Rules*, CASPER J. (Nov. 18, 2013), http://www.casperjournal.com/news/article_ca1c9c55-43b5-5062-81f2-9559f6c20475.html.

241. Laura Hancock, *Wyoming Will Demand Water Tests Before Oil and Natural Gas Drilling*, CASPER STAR TRIBUNE (Nov. 12, 2013), http://trib.com/business/energy/wyoming-will-demand-water-tests-before-oil-and-naturalgas/article_082be4f5-1c1d-5d38-ba8f-9fe43cf2a232.html.

242. *Id.*; *see also* Letter from John Robitaille, Vice President, Petroleum Ass'n of Wyo., to Wyo. Oil & Gas Conservation Comm'n 9 (Oct. 11, 2013) (on file with author).

company's perspective, because information regarding the presence of contaminants not associated with oil and gas activities might be useful to have in the event of a subsequent contamination dispute.[243]

G. *Should Testing Results Be Made Publicly Available?*

Another issue that has garnered some attention is whether baseline testing results should be made publicly available.[244] For purposes of helping avoid or resolve individual contamination disputes, it is not necessary that test results be released to the public. It is only necessary that test results be supplied to the oil and gas company and to the owner of the water source that is tested. Further, if test results are released to the public, fewer tests might be performed because some landowners may be reluctant to allow testing if test results are made publicly available.

The concerns that some landowners might have about test results being publicly released were aired during the public comment period for Wyoming's baseline testing regulation. In its comments, the Wyoming Stock Growers Association, which represents "many surface landowners," stated that it would have preferred to see the regulation accompanied by legislation protecting the confidentiality of baseline testing results, though the Association generally supported the proposed baseline testing rule—so long as landowners concerned about the disclosure of test results could refuse to allow testing.[245] A representative of the Association explained that its members had concerns both about adverse effects on property values that might result from reports of contamination and about the possibility that reports of contamination

243. To the extent that baseline testing is building a database of information that increases society's knowledge about groundwater quality generally, information regarding contaminants other than those associated with oil and gas activity would be useful, but a strong argument should be made that either: (1) mandatory testing should not include those analytes, or (2) that if such analytes are to be included in mandatory testing, any significant costs associated with testing for those substances should be borne by someone other than oil and gas companies—perhaps the industry associated with contamination by the other substances or the government.

244. Fladager, *supra* note 240.

245. Letter from Jim Magagna, Exec. Vice President, Wyo. Stock Grower's Ass'n, to Wyo. Oil & Gas Conservation Comm'n (Oct. 8, 2013) (on file with author).

might be used to support restrictions on cattle operations based on assertions that such operations can lead to contamination.[246]

In its comments, Marathon Oil similarly stated that it believed that making the test results publicly available would discourage landowners from allowing testing.[247] Further, a news report indicated that legislators had expressed concern about the impact that public disclosure of test results might have on landowners.[248]

Such concerns could convince a state to refrain from making test results publicly available, or to give the landowner the option to decide whether test results will be made publicly available. On the other hand, certain potential benefits of baseline testing, such as increasing the publicly available information on groundwater quality and whether oil and gas activity adversely impacts groundwater quality, are obtained only when results are made publicly available. At least one state—Illinois—generally allows a landowner to avoid public disclosure of test results, but the trend in state regulations seems to be that test results will be made publicly available.[249]

The Illinois statute provides that pre-fracturing test results generally must be disclosed to the Department of Natural Resoures, and that the Department must post the results on its website within seven days.[250] But the statute states that the owner of the water well may condition his consent to testing on a confidentiality agreement, and that if the operator and landowner enter a confidentiality agreement, the test results will not be given to the Department except under limited circumstances.[251] The statute states, however, that if baseline testing shows contamination above certain levels, the operator must disclose that infor-

246. Interview with Jim Magagna, Exec. Vice President, Wyo. Stock Grower's Ass'n (Dec. 16, 2013).

247. *See* Letter from Michael A. Williams to Grant Black, Supervisor, Wyo. Oil & Gas Conservation Comm'n (Oct. 7, 2013) (on file with author). Yates Petroleum Corporation expressed the same belief. *See* Letter from Shay R. Westbrook, Regulatory, Gov't Relations & Policy Analyst, Gene R. George & Assocs., Inc., to Grant Black, Supervisor, Wyo. Oil & Gas Conservation Comm'n (Oct. 11, 2013) (on file with author).

248. *See* Stephanie Joyce, *Legislative Committee Interrogates Baseline Testing Rule*, WYO. PUB. MEDIA (Sept. 30, 2013), http://wyomingpublicmedia.org/post/legislative-committee-interrogates-baseline-testing-rule.

249. 225 ILL. COMP. STAT. ANN. 732/1-80(d) (Westlaw through P.A. 98-626 of the 2013 Reg. Sess.).

250. *Id.* 732/1-80(b).

251. *Id.* 732/1-80(b), (d).

mation to the Department notwithstanding the parties' confidentiality agreement.[252]

Colorado rules provide that results are given to the Director of the Colorado Oil and Gas Conservation Commission and the landowner or owner of the water well.[253] The Colorado regulation also requires the Commission to make the results publicly available.[254]

Wyoming's testing regulations require the operator to give copies of all sample analyses to the owner of the water source and the Wyoming Oil and Gas Conservation Commission.[255] The Commission must then make that information available to the public, "unless the data is otherwise considered confidential under Wyoming statute," and state regulators have suggested that test results generally will not be deemed confidential.[256]

The California statute requires that test results be provided to the Division of Oil, Gas, and Geothermal Resources in the Department of Conservation, the appropriate regional water board, and the landowner.[257]

In Ohio, the operator must conduct sampling, testing, and include the test results in an application for a permit to drill filed with the Ohio Department of Natural Resources Oil and Gas Division.[258] Ohio law also seems to require that the operator provide copies to the landowner and, if requested, to local government.[259] This requirement is stated in the "Best Management Practices for Pre-Drilling Water Sampling."[260]

H. *Should Landowners Be Required to Allow Testing?*

Someone could raise the question of whether states should require landowners to allow baseline testing of water sources locat-

252. *Id.* 732/1-80(d)(4).

253. COLO. CODE REGS. § 404-1:609(f) (2014).

254. *Id.* § 404-1:609(f)(1).

255. WYO. CODE R. (Oil & Gas Conservation Comm'n), ch. 3 § 46(g) (2014).

256. *Id.*

257. CAL. PUB. RES. CODE § 3160(d)(7)(C) (West Cum. Supp. 2014).

258. OHIO REV. CODE ANN. § 1509.06(A)(8) (LexisNexis Repl. Vol. 2013); *see* OHIO DEP'T OF NATURAL RES. OIL & GAS DIV., BEST MANAGEMENT PRACTICES FOR PRE-DRILLING WATER SAMPLING 2 (2012) [hereinafter BEST MANAGEMENT PRACTICES].

259. *See* OHIO REV. CODE ANN. § 1509.06(A)(9).

260. *See* BEST MANAGEMENT PRACTICES, *supra* note 258, at 4.

ed on their land. So far, no state has done so. Most state laws do not expressly state that a landowner may refuse to allow testing, but do clearly contemplate that a landowner has the right to refuse to allow testing.[261] For example, Ohio's statute requires oil and gas companies to identify (in their applications for permits to drill) all water well owners who have not allowed the companies to collect samples for testing.[262] California's statute requires companies to perform testing of water sources if the landowner requests testing.[263]

Recognizing the right of landowners to refuse to allow testing may be the best approach. Sample collection might involve at least some inconvenience for the landowner. And some landowners may wish to refuse baseline testing in order to avoid public disclosure of their groundwater quality. Further, although baseline testing can benefit landowners, if a landowner prefers to forego that benefit and refuse to allow testing, that is arguably the landowner's business. But some people might conclude that a landowner's decision to forego such potential benefits is also society's business and that the law should require landowners to allow testing. Such reasoning has precedent in numerous laws that impose requirements designed primarily to benefit the person whose conduct is being regulated.[264] Furthermore, a requirement that landowners allow baseline testing would likely not be any more intrusive than some other regulations.

Moreover, landowners are not the only people who can benefit from baseline testing. If baseline testing shows that groundwater contained certain contaminants prior to oil and gas drilling, those test results could protect the oil and gas company from being er-

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261. *See, e.g.*, COLO. CODE REGS. § 404-1:609(c)(3) (2014); 225 ILL. COMP. STAT. 732/1-80(d) (Westlaw through P.A. 98-626 of the 2013 Reg. Sess.); WYO. CODE R. (Oil & Gas Conservation Comm'n), ch. 1 § 2(e) (2014) (defining "available water source" as being certain types of water sources for which the "owner . . . has given consent for sampling and testing"); *see also* WYO. CODE R. (Oil & Gas Conservation Comm'n), ch. 3 § 46(d)(iii).

262. OHIO REV. CODE ANN. § 1509.06(A)(8)(b) (providing that an application to drill a vertical oil and gas well in an urbanized area must identify the water well owners that have *denied* the applicant permission to test a water well located within 300 feet of the proposed vertical well); *id.* § 1509.06(A)(8)(c) (providing that an application to drill a horizontal oil and gas well must identify the water well owners that have *denied* the applicant permission to test a water well located within 1500 feet of the proposed horizontal well).

263. CAL. PUB. RES. CODE § 3160(d)(7) (West Cum. Supp. 2014).

264. One of many examples is a regulation that requires drivers to wear seat belts. *See Seat Belt Laws*, GOVERNORS HIGHWAY SAFETY ASS'N, http://ghsa.org/html/stateinfo/laws/seatbelt_law.html (last visited Feb. 18, 2014).

roneously blamed for that contamination later. Further, to the extent that baseline testing sheds light on the level of risk involved in hydraulic fracturing, it can help the public, elected officials, and regulators make decisions regarding what regulations are appropriate. These reasons could also be cited to support requiring landowners to allow baseline testing.

I. *Should States Encourage the Use of Tracers?*

An emerging issue is whether states should encourage the use of tracers. A variety of tracer technologies exist, including chemical tracers and radioactive tracers.[265] Apparently, however, some of these tracers are effective only near the wellbore and perhaps for only a relatively short time after fracturing, and thus might not be very effective in helping diagnose whether fracturing has caused contamination.[266]

But other researchers are working on different tracer technologies, such as tracers based on magnetic nanoparticles[267] or DNA molecules[268] designed to help resolve contamination claims. Reportedly, such tracers could be varied so that fluids used in operations at each oil and gas well could be given a unique marker.[269] Such tracers are still in the early stages of development, so it is not yet clear how effective the technologies will become or whether testing for a tracer will be a good substitute for testing for a broader range of substances.

Because some of the emerging tracer technologies are so new, many states will likely choose not to incorporate provisions for tracer technology in their regulations at this time. But North Carolina's proposed baseline testing regulation would allow a

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265. *See* Andrew C. Revkin, *Ideas to Watch in 2013: Traceable Gas-Drilling Fluids*, N.Y. TIMES (Jan. 8, 2013, 11:31 AM), http://dotearth.blogs.nytimes.com/2013/01/08/ideas-to-watch-in-2013-traceable-frackin-fluids/?_php=true&_type=blogs&_r=0.

266. *See* Tay Wiles, *New Tech to Trace Fracking Fluid Could Mean More Accountability*, HIGH COUNTRY NEWS (Aug. 22, 2013, 2:55 PM), http://www.hcn.org/blogs/goat/fracking-technology-oil-and-gas-drilling-regulation.

267. One company states that its "tracer technology consists of magnetic nanoparticles constructed with a proprietary coating whose properties exhibit a specific magnetic profile," and that the "profile acts as a 'signature', uniquely identifying a specific batch of tracer material." *See The Technology: Thinking Small*, FRACENSURE, http://www.frac-ensure.com/the-technology (last visited Feb. 18, 2014).

268. *See About Our Technology*, BASETRACE, http://basetrace.com/technology (last visited Feb. 18, 2014).

269. *Id.*

company that uses tracer technology approved by the state's oil and gas regulators to perform post-drilling testing of groundwater for the presence of the tracer in lieu of testing for certain other substances.[270] North Carolina's willingness to consider such tracers may help spur innovation that could potentially lower costs and provide a more definitive resolution of disputes regarding the cause of contamination.

J. *Who Pays for Baseline Testing?*

All testing regulations place the burden of paying for sample collection and testing on the oil and gas company. For example, California Public Resources Code section 3160(d)(7)(B) expressly requires the "owner or operator" of the oil and gas well to pay for the water testing.[271] The baseline testing laws of most other states do not expressly discuss who pays for the testing, but the laws make the collection and testing an obligation of the oil and gas company.

K. *Who Actually Performs the Sampling and Testing?*

Another question is who actually performs the sampling and testing that the oil and gas company will pay for. There seems to be a consensus that water sample analysis or testing should be done by an appropriately certified laboratory.

Some regulations also expressly specify that an independent laboratory should conduct the testing, and some even specify that an independent company should perform the sample collection. It is not clear that it is justified to make this a requirement, particularly for *pre*-fracturing sampling and testing. For pre-fracturing sampling, there is no incentive for a company to obtain a false "negative"—that is, a test indicating that a water supply is free of contamination. If a water supply is contaminated prior to fracturing, the oil and gas company would want that fact to be documented. Further, it seems highly unlikely that a company would deliberately create a false "positive" in pre-fracturing test-

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270. *See* Marisa Grant, *Local Technology Could Help Ease N.C. Fracking Concerns*, N.C. HEALTH NEWS (Jan. 9, 2014), http://www.northcarolinahealthnews.org/2014/01/09/local-technology-could-help-ease-n-c-fracking-concerns/.

271. CAL. PUB. RES. CODE § 3160(d)(7)(B) (West Cum. Supp. 2014).

ing. Not only would most persons avoid deliberate dishonesty, but a pre-fracturing test result that shows significant contamination would likely draw attention and result in independent, follow-up testing.

But it seems unlikely that requiring an independent entity to perform both sample collection and testing will cause problems, and perhaps the use of independent entities will give some people more confidence in the results. Moreover, many oil and gas companies already prefer hiring contractors to perform sample collection and testing anyway, rather than doing it with their own personnel.

California Public Resources Code section 3160(d)(7)(B) contemplates sampling and testing by independent third parties.[272] In contrast, Colorado's regulations do not seem to require that the operator retain an independent entity to conduct sampling and analyses.[273] The Ohio statute and related publications seem to contemplate that the operator will collect the sample following certain protocols, but that a certified laboratory will analyze the sample.[274]

Wyoming's regulations seem to contemplate that the operator of the oil or gas well will perform the sample collection. The analyses must be performed by an accredited laboratory.[275] But Wyoming's regulations require that a registered professional engineer oversee the sample collection.[276] At least one comment submitted during the public comment period questioned this requirement.[277] The comment stated that many people who are well-trained and experienced in sample collection techniques are not registered professional engineers, and that requiring a professional engineer to oversee the sample collection will add cost without providing a benefit.[278] Further, the comment stated that the training and edu-

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272. *Id.*

273. COLO. CODE REGS. § 404-1:609(c) (2014).

274. *See* OHIO REV. CODE ANN. § 1509.06(A)(8) (LexisNexis Repl. Vol. 2013); BEST MANAGEMENT PRACTICES, *supra* note 258, at 3.

275. WYO. CODE R. (Oil & Gas Conservation Comm'n), app. K § 2.4.

276. *Id.*

277. Letter from Michael L. Bergstrom, Onshore Sci. & Regulatory Advisor, Shell Exploration & Prod. Co., to State of Wyo., Wyo. Oil & Gas Conservation Comm'n (Oct. 11, 2013) (on file with author).

278. *Id.*

cation necessary for a person to become a registered professional engineer does not necessarily include water sampling protocols.[279]

CONCLUSION

In some areas, shallow sources of underground drinking water have never been sampled and analyzed to determine groundwater quality. This can lead to several problems. For example, many landowners use water from private water wells that are contaminated. The contamination may come from natural sources or from human activity, and often the landowners who use such water are unaware of the contamination.

Second, when a groundwater contamination problem is discovered, the absence of *prior* data can make it difficult to know how long the contamination problem has existed, and can complicate the task of determining what caused the contamination. This might lead to a landowner erroneously blaming the contamination on someone who did not cause it, or might allow someone who caused the contamination to escape liability.

In turn, the difficulty in proving the cause of contamination can lead to a third problem—confusion amongst the public, regulators, and public officials regarding the level of risk associated with various activities, including hydraulic fracturing. Many people worry that hydraulic fracturing frequently causes groundwater contamination, though the available evidence suggests that hydraulic fracturing rarely causes contamination. Baseline testing of groundwater can address these problems.

States should require oil and gas companies to perform baseline testing of groundwater prior to hydraulic fracturing, and states should consider requiring baseline testing prior to all oil and gas drilling. States should not use rebuttable evidentiary presumptions that hydraulic fracturing has caused groundwater contamination, unless such presumptions are used only as a sanction for a company's failure to conduct required baseline testing. States should not use irrebuttable or conclusive presumptions that hydraulic fracturing has caused contamination in any circumstances.

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279. *Id.*

APPENDIX—DIFFERENT STATE APPROACHES TO BASELINE TESTING

A. *California*

In September 2013, California enacted Senate Bill 4. That legislation contains several provisions to regulate hydraulic fracturing, including provisions relating to the baseline testing of water supplies prior to hydraulic fracturing. For example, the legislation requires operators to arrange for an independent person or entity to identity and notify all persons who own land that is located within 1500 feet of the wellhead location or 500 feet of the horizontal projection of the wellbore.[280] This must be completed at least thirty days before hydraulic fracturing is performed.[281] In addition, the legislation gives those landowners the right to request the collection and testing of water samples from any water well or surface water source that supplies water suitable for drinking or irrigation.[282] The operator must pay for an independent contractor to collect and test such samples before hydraulic fracturing is performed and to collect and test additional samples after hydraulic fracturing is performed "on the same schedule as the pressure testing of the well casing."[283] The test results must be provided to the property owner, the Department of Conservation's Division of Oil, Gas and Geothermal Resources, and to the "appropriate regional water board."[284] The legislation directs the State Water Resources Control Board to develop protocols for the sampling and testing.[285] The legislation specifies the analytes for which testing must be performed. Presumably, the protocols that the Water Resources Control Board develops may specify the required analytes.

280. CAL. PUB. RES. CODE §§ 3160(d)(6)(A)(i)–(ii) (West Cum. Supp. 2014).
281. *Id.* § 3160(d)(6)(C).
282. *Id.* § 3160(d)(7)(A).
283. *Id.* §§ 3160(d)(7)(A)(i)–(ii).
284. *Id.* § 3160(d)(7)(C).
285. *Id.* § 3160(d)(7)(B).

B. *Colorado*

Colorado's regulations require that an operator collect and analyze samples from all "Available Water Sources"[286] located within one-half mile radius of a proposed "Oil and Gas" well if four or fewer sources exist (assuming the owner of the water source consents to testing).[287] If more than four sources exist, the operator must choose four sample locations, based on criteria stated in the regulation.[288] The selection criteria establish a preference for: (1) selecting water sources that are nearer, rather than further, from the proposed oil and gas well; (2) sampling water from well-maintained domestic water wells; (3) including, if groundwater flow direction is known, sample locations both up-gradient and down-gradient from the proposed oil and gas well; and (4) if groundwater flow direction is unknown, choosing sample locations in a radial pattern around the proposed oil and gas well.[289]

Although the definitions of "Oil Well" and "Gas Well" do not expressly preclude an argument that the one-half mile distance within which testing must be performed is measured from the wellhead only, as opposed to the entire lateral of a horizontal well, the regulation seems to consider the "Oil and Gas Well" to mean the wellhead.[290] For example, the regulation refers to a one-half mile "radius" around the well.[291] The word "radius" only makes sense if the location of the well is at a point on the surface, such as the wellhead, rather than a line stretching as much as a mile or more along the surface. Further, the testing rule provides that, when the direction of subsurface water flow is known, water sources up-gradient and down-gradient, rather than cross-gradient, are preferred for test locations.[292] Those descriptions

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286. "Available Water Source" is defined as meaning "a water source for which the water well owner, owner of a spring, or a land owner, as applicable, has given consent for sampling and testing and has consented to having the sample data obtained made available to the public, including without limitation, being posted on the [Colorado Oil and Gas Conservation Commission] website."
COLO. CODE REGS. § 404-1:100 (2014).

287. COLO. CODE REGS. § 404-1:609(b) (2014).

288. *Id.*

289. *Id.* If aquifers exist at different depths, the operator should attempt to sample from the shallowest and the deepest depth. *Id.* § 404-1:609(b)(4).

290. *Compare* COLO. CODE REGS. § 404-1:100, *with* COLO. CODE REGS. § 404-1:609(b).

291. COLO. CODE REGS. § 404-1:609(b).

292. *Id.* § 404-1:609(b)(3).

would not make sense if the well location was considered as being the entire length of a lateral, rather than just the wellhead. Thus, it is reasonably clear that the location of the "Oil and Gas Well" is the wellhead.

In addition to the pre-drilling sampling and testing, the operator must collect and test samples between six and twelve months after completion of an "Oil and Gas Well" that is put into production, and again between sixty and seventy-two months after the well is completed.[293] If the "Oil and Gas Well" is abandoned without ever being put into production, the post-completion sampling and testing requirements do not apply.[294]

The initial sample must be analyzed for a long list of analytes listed in the regulation.[295] The person collecting the sample also must record a number of field observations, including water color, the presence of any odors, sediment, bubbles, or effervescence.[296] The post-completion samples, if required, must be tested for a lengthy list of analytes, though it is shorter than the list of analytes for the initial sample.[297] If a concentration of methane greater than 1.0 milligrams per liter is found in any sample, the methane must be tested for isotopic composition to determine gas type.[298]

C. *Ohio*

Ohio statutes require groundwater testing prior to drilling wells in urban areas and prior to drilling horizontal wells. Prior to drilling a horizontal well, water wells within 1500 feet of the oil and gas wellhead must be tested, assuming the water well owner consents.[299] If an oil or gas well is not going to be a horizontal well, but it will be located within an urban area, water wells within 300 feet of the oil and gas wellhead must be tested, assuming that the water well owner consents.[300] The statute states that testing should be performed in accordance with the Ohio Depart-

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293. *Id.* § 404-1:609(d)(2).
294. *Id.*
295. *Id.* § 404-1:609(c)(2).
296. *Id.*
297. *Id.* § 404-1:609(e)(3).
298. *Id.* § 404-1:609(e)(4).
299. OHIO REV. CODE ANN. § 1509.06(A)(8)(c) (LexisNexis Repl. Vol. 2013).
300. *Id.* § 1509.06(A)(8)(b).

ment of Natural Resources Oil and Gas Division's "Best Management Practices For Pre-Drilling Water Sampling," which specifies certain protocols and provides a list of analytes for which samples must be tested.[301]

D. *Illinois*

In 2013, Illinois enacted the "Hydraulic Fracturing Regulatory Act." The Act requires an operator to perform baseline testing "[p]rior to conducting high volume horizontal hydraulic fracturing operations."[302] The testing requirement applies to "all water sources within 1,500 feet of the well site."[303] The legislation defines "[w]ell site" to mean "surface areas, including the well, occupied by all equipment or facilities necessary for or incidental to high volume horizontal hydraulic fracturing operations, drilling, production, or plugging a well."[304] This suggests that the distance within which water sources must be tested is effectively measured from the area around the wellhead, rather than from all locations along the lateral of a horizontal well. "Water source" is defined to mean "(1) any existing water well or developed spring used for human or domestic animal consumption, or (2) any river, perennial stream, aquifer, natural or artificial lake, pond, wetland listed on the Register of Land and Water Reserves, or reservoir."[305] Thus, except for water bodies on the register, the testing requirement only applies to water wells and springs that are actually used.

If a portion of an aquifer is located within 1500 feet of the oil or gas well, but no water wells that utilize that aquifer are within 1500 feet of the oil and gas well (or no owner of a water well that accesses the aquifer within 1500 feet of the oil and gas well has consented to testing), the operator must arrange for the collection and analysis of a sample from the nearest water well (that ac-

301. *Id.* § 1509.06(A)(8)(b)–(c); *see* BEST MANAGEMENT PRACTICES, *supra* note 258 at 2–4.

302. 225 ILL. COMP. STAT. ANN. 732/1-80(b) (Westlaw through P.A. 98-626 of the 2013 Reg. Sess.) "High volume horizontal fracturing operations" are defined as fracturing operations that use more than 300,000 gallons of water. 225 ILL. COMP. STAT. ANN. 732/1-5 (Westlaw through P.A. 98-626 of the 2013 Reg. Sess.)

303. 225 ILL. COMP. STAT. ANN. 732/1-80(b).

304. 225 ILL. COMP. STAT. ANN. 732/1-5.

305. *Id.*

cesses the aquifer) whose owner will consent to testing.[306] In addition to arranging for such sampling and testing prior to conducting hydraulic fracturing operations, the operator also must arrange for such sampling to be conducted six months, eighteen months, and thirty months after the high volume horizontal fracturing operation is complete.[307]

The operator must retain an independent third party to conduct the sampling and testing.[308] The test results must be provided to the Department of Natural Resources, unless the owner of the water source conditioned his consent to sampling on the operator agreeing to a nondisclosure agreement, in which case the results must be provided to the owner of the water source.[309] The Act specifies the analytes for which samples must be tested.[310]

In addition to requiring such testing, the Act also creates a rebuttable presumption that the operator is liable for pollution of water supplies in certain situations.[311] The rebuttable presumption applies if a water source is located within 1500 feet of the oil or gas well, the pre-fracturing testing did not show the existence of contamination, and contamination occurs during the hydraulic fracturing operation or within thirty months after the operation is completed.[312] The Act makes the presumption particularly onerous by stating that, to rebut the presumption, the operator must show "by clear and convincing evidence," rather than a preponderance of the evidence, that the contamination was caused by some "identifiable cause" other than the hydraulic fracturing.[313] Thus, not only does the Act create a presumption adverse to the operator, but the Act heightens the standard of proof for a rebuttal. The Act arguably requires the operator to prove what the source actually was. This is an additional burden because in certain circumstances, an operator might be able to conclusively prove that it did not cause contamination, but be unable to determine what the actual source was.

306. *Id.* 732/1-80(b).
307. *Id.* 732/1-80(c).
308. *Id.* 732/1-80(b).
309. *Id.* 732/1-80(c).
310. *Id.* 732/1-80(e).
311. *Id.* 732/1-80(b).
312. *Id.*
313. 225 ILL. COMP. STAT. ANN. 732/1-85(c) (Westlaw through P.A. 98-626 of the 2013 Reg. Sess.).

As with some other state statutes that create similar presumptions, the Act specifies that an operator can "rebut" the presumption by proving that the contamination did not occur during the presumption window, though this portion of the Act creates ambiguity.[314] If the water source is not within 1500 feet of the oil and gas well, the contamination occurred prior to the hydraulic fracturing operation, or the contamination occurred more than thirty months after the hydraulic fracturing operation, then under the terms of the Act itself, the presumption should not apply.[315] Therefore, the operator should have no need to rebut it.

E. *North Carolina*

North Carolina requires that all new oil and gas leases include a provision that obligates the lessee to perform baseline testing of all water supplies within 5000 feet of the wellhead prior to drilling and on at least two additional occasions within twenty-four months after drilling.[316] The statute gives landowners the right to have the North Carolina Department of Natural Resources collect water samples, instead of the lessee collecting samples, and if a landowner exercises that right, the lessee must reimburse the department for the reasonable costs of collecting samples.[317] The statute also expressly provides that it does not abrogate any landowner's right to refuse to allow pre-drilling testing.[318] In addition, the State imposes a rebuttable presumption that an oil and gas well operation is liable for any contamination occurring within 5000 feet of its oil and gas well.[319]

The North Carolina Department of Natural Resources' Division of Energy, Mineral and Land Resources is working on proposed regulations that would list numerous analytes for which testing must be conducted.[320] The draft North Carolina rules also contain a provision that would give the division the authority to approve the use of tracer technology and testing for a tracer that could be

314. *Id.* 732/1-85(c)(2).

315. *Id.* 732/1-85(c).

316. N.C. GEN. STAT. § 113-423(f) (2013).

317. *Id.*

318. *Id.*

319. *Id.* § 113-421(a1) (2013).

320. DIV. OF ENERGY, MINERAL & LAND RESOURCES, N.C. DEP'T OF NATURAL RES., BASELINE AND SUBSEQUENT TESTING REQUIREMENTS 1 (2013), *available at* http://portal.ncdenr.org/web/mining-and-energy-commission/draft-rules.

added to fracturing fluid as a substitute for some of the testing that otherwise would be required in the second round of post-production testing.[321] The draft regulations specify that the tracer technology would have to be a technology that did not have chemical or radiation impacts that would be harmful to human health.[322]

F. *Pennsylvania*

Pennsylvania law does not require operators to conduct baseline testing of groundwater prior to drilling for oil or gas or prior to hydraulic fracturing, but it creates certain presumptions that may encourage testing. For example, Pennsylvania's Oil and Gas Act creates a presumption that the operator is responsible for the pollution of a water supply if: (1) the water supply is within 1000 feet of the oil or gas well and the pollution occurs within six months of the completion of drilling or (2) the water supply is within 2500 feet of the vertical section of an unconventional well and the pollution occurred within twelve months of the completion of drilling or hydraulic fracturing of the well.[323]

If the operator had an independent, certified laboratory conduct baseline testing of the groundwater supply prior to drilling, the presumption is a rebuttable evidentiary presumption that the operator can rebut by demonstrating that the pollution occurred as a result of some other cause.[324] The operator also can rebut the presumption by showing that the owner of the water supply did not allow testing to be performed.[325]

If the owner of the water supply allowed testing, but the operator nevertheless did not perform background testing, the Pennsylvania Oil and Gas Act arguably appears to make the presumption irrebuttable. In particular, the statute refers to the obligation of an oil and gas operator to conduct pre-drilling testing if the operator "elect[s] to preserve" its right to rebut the presumption.[326] This could make the operator who does not perform

321. *Id.* at 5.
322. *Id.*
323. 58 PA. CONS. STAT. ANN. § 3218(c) (West Cum. Supp. 2013).
324. *Id.* § 3218(d), (e).
325. *Id.* § 3218(d)(1)(ii).
326. *Id.* § 3218(e).

baseline testing legally responsible for pollution of a water supply, even if the operator could affirmatively prove that he did not cause the pollution and that instead there was some other cause.

Test results must be given to the Pennsylvania Department of Environmental Protection and the owner of the water supply that is tested.[327]

Finally, a potential ambiguity in the statute should be noted. Under the language of the statute, the presumption does not apply unless certain predicate facts are true. Namely, the presumption does not apply unless: the pollution occurred within twelve months after completion or fracturing of the oil and gas well (assuming an unconventional well), and the water supply is within 2500 feet from the vertical section of the oil and gas well.[328] And, if the presumption does not apply, then the defendant should have no need to rebut it. But the portion of the statute that discusses rebuttal of the presumption states that a defendant can rebut the presumption by showing that the pollution did not occur within twelve months of the fracturing or within 2500 feet of the oil and gas well.[329]

This leads to a question. If a defendant in a contamination suit asserts that the contamination did not appear within twelve months of his completing his oil and gas well or that the contaminated water supply is not within 2500 feet of his oil and gas well, is the defendant rebutting the presumption or simply asserting that the presumption does not apply because the predicate facts necessary to trigger the presumption are not true?

This question matters for two reasons. First, although the defendant would have the burden of rebutting the presumption, the plaintiff should have the burden of proving the predicate facts necessary to trigger the presumption in the first place.[330] Second, the question matters because a defendant that fails to perform baseline testing may lose its right to rebut a presumption, but it should not lose the right to assert that the predicate facts necessary to trigger a presumption are not true.

327. *Id.*

328. *Id.* § 3218(c).

329. *Id.*

330. Thus, for the presumption to apply, the plaintiff should have to show that the allegedly contaminated water source is within 2500 feet of an oil and gas well and that the contamination appeared within twelve months of completing the well. *See id.* § 3218(c).

The only reasonable way to resolve the ambiguity is to conclude that the defendant who asserts that the predicate facts are not true is arguing that the presumption does not apply. He is not rebutting the presumption. This is consistent with basic legal principles about what presumptions are and how they work. Further, this particular resolution of the ambiguity is necessary to avoid absurd results. Suppose for example, that a water supply located in southeast Pennsylvania becomes contaminated several years after completion of a gas well located hundreds of miles away in northwestern Pennsylvania, and the operator of the gas well failed to perform baseline testing. Obviously the plaintiff should not be able to rely on the presumption, asserting that the defendant has lost its right to "rebut" the presumption.

G. *West Virginia*

Like Pennsylvania, West Virginia does not require baseline testing, but it establishes certain presumptions that may encourage testing. The West Virginia Horizontal Well Act provides that, if a water supply is located within 1500 feet of the center of the wellhead of a horizontal oil or gas well, and that water supply becomes contaminated, there will be a presumption that the operator of the oil or gas well caused the contamination.[331] The presumption generally is rebuttable, whether or not the operator performs baseline testing, but the statute seems to prohibit the operator from rebutting the presumption by proving that the "pollution existed prior to the drilling" unless the operator has performed baseline testing using an independent, certified laboratory.[332]

The operator can rebut the presumption by proving that the owner of the water source refused to allow testing, that the pollution occurred more than six months after drilling, that the pollution had some cause other than the drilling, or (assuming that baseline testing was done) that the pollution existed before the drilling.[333] Also, the West Virginia statute states that the operator

331. W. VA. CODE ANN. § 22-6A-18(b) (LexisNexis Supp. 2013).

332. *Id.* § 22-6A-18(b)(1); *see also id.* § 22-6A-18(d) ("Any operator electing to preserve its defenses [that the contamination pre-dated the drilling] shall retain the services of an independent certified laboratory to conduct the predrilling or prealteration water well test.").

333. *Id.* § 22-6A-18(c).

can rebut the presumption by showing that the water source is not within 1500 feet of the wellhead, but the location of the water source relative to the well should control whether the presumption applies, not whether it can be rebutted.[334]

Test results must be provided to the owner of the water supply and to the West Virginia Department of Environmental Protection.[335]

H. *Wyoming*

Wyoming's regulations require testing of water wells and springs located within one-half mile of the surface location of any new oil or gas well that is to be drilled, whether or not the well is to be hydraulically fractured.[336] If four or fewer such water sources exist, then all must be tested (if the owner of the water source consents).[337] If there are more than four, the operator must submit a testing plan to the Wyoming Oil and Gas Conservation Commission ("WOGCC") for selecting water sources to test based on certain criteria stated in the regulation (such as a preference for testing the water sources nearest the oil and gas well, and selecting sources that are located in a radial pattern around the oil and gas well).[338] The regulation also requires two rounds of post-drilling testing—one between twelve and twenty-four months after the production casing is set and another between thirty-six and forty-eight months after the production casing is set.[339] The test results must be submitted to WOGCC within three months of sample collection, and WOGCC is directed to make the results available to the public.[340] The rule lists a broad range of analytes for which the operator must test,[341] and requires isotopic charac-

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334. *Id.* § 22-6A-18(c)(3).
335. *Id.* § 22-6A-18(d).
336. WYO. CODE R. (Oil & Gas Conservation Comm'n), ch. 3 § 8(c)(iii) (2014).
337. *Id.* ch. 3 § 46(b).
338. *Id.* ch. 3 § 46(c).
339. *Id.* ch. 3 § 46(e).
340. *Id.* ch. 3 § 46(g).
341. *See id.* ch. 3 § 46(h) ("The initial and subsequent sampling and testing described in this section shall at a minimum include temperature, pH, oxidation-reduction potential, specific conductance, turbidity, dissolved oxygen, total dissolved solids (TDS), dissolved gases (methane, ethane, propane), alkalinity (total bicarbonate and carbonate as CaCO3), major anions (bromide, chloride, fluoride, sulfate, nitrate and nitrite as N, phosphorus), major cations (calcium, iron, magnesium, manganese, potassium, sodium), other elements (barium, boron, selenium and strontium), presence of bacteria (iron related, sulfate reduc-

terization of methane if the concentration of that compound exceeds 5.0 milligrams per liter.[342]

I. *Alaska*

Alaska's proposed regulation would require testing of water wells that are located within one-half mile of the "wellbore trajectory" of an oil or gas well that is to be hydraulically fractured if the water well's owner consents to testing.[343] The regulation lists a large number of analytes for which the operator must test[344] and also requires the documentation of various field observations.[345] In addition, the proposed regulation would require certain isotopic characterizations of methane if that compound is detected in concentrations greater than 1.0 milligram per liter.[346] Such characterizations can help in determining whether the methane is biogenic (formed through biologic processes) or thermogenic (formed through chemical processes, typically when organic matter is subjected to high temperatures and pressures), which can provide clues regarding whether natural forces or human activity have caused the methane to be present. Test results must be submitted to the Alaska Department of Environmental Conservation within ninety days of the samples being collected.[347] The proposed regulation does not generally require post-fracturing testing, but states that the Alaska Oil and Gas Conservation Commission may require post-fracturing testing.[348]

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ing, slime forming), total petroleum hydrocarbons (TPH), BTEX compounds (benzene, toluene, ethylbenzene and xylenes), and naphthalene.")

342. *Id.* ch. 3 § 46(i).

343. ALASKA ADMIN. CODE tit. 20, § 25.283(a)(4) (proposed Dec. 20, 2012).

344. *See id.* ("The sample parameters shall include pH; Alkalinity (total bicarbonate and carbonate as CaO3); specific conductance; bacteria presence (iron related, sulfate reducing, slime forming); arsenic; barium; bicarbonate; boron; bromide; cadmium; calcium; chloride; chromium; fluoride; hydroxide; iodide; iron; lithium; magnesium; manganese; nitrate and nitrite as N; phosphorus; potassium; radium (measured by radium 226 and 228); selenium; silicon; sodium; strontium; sulfate; Total Dissolved Solids; BTEX/GRO/DRO (Benzene, Toluene, Ethylbenzene, Xyleneby–method EPA 5035/ SW 846 8260B) (Gasoline Range Organics–by method EPA 5035/8015D) (Diesel Range Organics–by method EPA 8015D with silica gel cleanup); PAH's (Polynuclear Aromatic Hydrocarbons including benzo(a)pyrene); Dissolved Methane, Dissolved Ethane, and Dissolved Propane.").

345. *Id.* ("Field observations such as odor, water color, sediment, bubbles, and effervescence shall also be documented.").

346. *Id.*

347. *Id.* § 25.283(a)(4)(D).

348. *Id.* § 25.283(j).